THE ROMANCE of BUSINESS

By

W. CAMERON FORBES


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HUDDLED HALF-NAKED CREATURES IN CRAZY SHELTERS OF GRASS, MUD, AND LEAVES (*page 234*)

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BY

W. CAMERON FORBES

WITH ILLUSTRATIONS BY

A. L. RIPLEY

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PREFACE

The editors of *The Open Road* did me the honor to consult me in regard to some of the problems confronting their paper in its early days; and in the course of our conversation I suggested the advisability of their running a series of articles calculated to explain the nature of business, in the hope that it would remove some of the prejudices that many people wrongly hold against business. I pointed out how little was realized of the vital part business plays in our lives, and urged the editors to find some one to undertake the job. They countered my suggestion by asking me to write the articles myself, which, after some hesitation because of a pressure of other occupations, and partly, too, through disinclination to write, I finally agreed to do; and the articles duly appeared.

In this work I had the valuable coöperation of a number of men who are experts in their particular fields, and I wish here

to express my hearty appreciation of their assistance. They are my brother, Dr. Alexander Forbes, who wrote the larger part of the paper on Electricity; John J. Carty, of the American Telephone and Telegraph Company; Colonel Charles R. Gow; Ray Morris, of Brown Brothers & Company; Russell Robb, of Stone & Webster; and Clayton H. Ernst, Charles B. Hawes, and Ormond E. Loomis, of *The Open Road.* My thanks are also due, for much valuable help, to the First National Bank of Boston, and Arthur D. Little, Inc.; as well as to Mr. A. L. Ripley, who made the illustrations.

I hope this reissue in book form, in reaching a new set of readers, will continue to carry out the purpose of these articles, bring about a better understanding of some of our problems, and tend to correct the dangerous fallacy that property is an evil and business somewhat reprehensible. If this is accomplished, the book will serve a useful purpose.

W. Cameron Forbes

September, 1921

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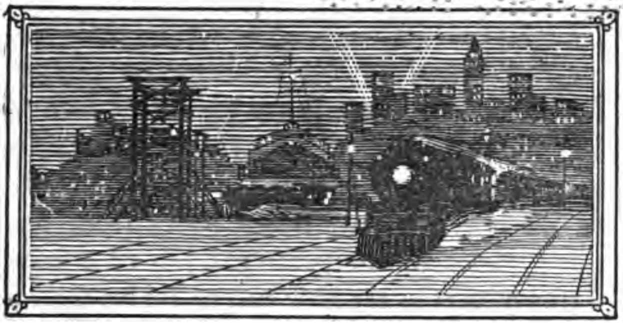

THE ROMANCE OF BUSINESS

I

WHAT IT REALLY IS

A GREAT many persons to-day do not seem to understand the fundamental nature of business, particularly big business. This misapprehension is so insistent, general, and widespread that a few words of definition and explanation may prove to be useful — especially to the young men who are making or will soon make their start.

Business is constantly being held up as something reprehensible and corrupt. A business career is too often looked upon as

organized and lawful robbery or piracy. There seems to be a fairly prevalent feeling that there is a fixed amount of money or wealth in the world, and that what is made by one is necessarily taken away from another, and that the principal job of a man of business is to see how successful he can be in separating other people from their possessions in order to augment his own. This naturally leads to the conclusion that big business differs from lesser business only in that the iniquities are practiced on a larger scale — wholesale robbery instead of petty thievery. The object of these pages is to give a true picture of the essence of business in the hope that it will serve to chase away some of the fog of misunderstanding.

Our modern civilization would make a very sorry picture if these conceptions of business were true, as almost every one is engaged in some sort of business or obtains his means of livelihood as a result of business, and if these theories were based even to a small degree on fact it would mean that our whole human development had been unsound and was rotten at the heart.

Of course this is not so. Business is really service. One who devotes himself to legitimate business devotes himself to the service of mankind; and if the business is done properly it must naturally follow that the bigger the business, the greater the service. Under an ideal social, political, and economic system, the return in wealth, comfort, conveniences, and privileges should be reasonably proportionate to the service rendered by each individual or his ancestors. In so far as the returns are not proportionate to the service rendered, our system is faulty. The remedy, however, is to seek out and correct the abuses, and, by proper laws and practices, to make the conduct of business such that the community is well served. A skillful gardener will not cut a tree down to make it grow better; he will cultivate it and prune it.

Let us now look at the essence of business and try to prove our case. It is always well to strip our system of most of its complexities and go back to origins, which are easier to understand and are more strikingly illustrative. Let us imagine a village composed

of a few families, each one of which procures its own food, cures its own skins, cares for its own sick, protects its own women and children from attack, and builds and maintains its own shelters. Let us assume that one man among these conceives the idea that this group should specialize: that one sharper of eye, stronger of hand, and sounder of wind than the others should hunt for all; another, crippled perhaps in an unfavorable encounter with a bear or a human enemy, should cure all the skins and prepare the moccasins and other garments; a third, whose tastes and abilities run along these lines, should clear and plant the land and harvest the corn; a fourth should catch, salt, and dry the fish; a fifth devote himself to the study and preparation of healing herbs and care for the health of all; and others should keep watch and become skilled in arms in order to protect the families of all from the attacks of enemies. And so let us imagine that each performs for the community the thing he is best fitted to do — and finds in the doing of it further skill. He who cures and dresses skins

learns new devices to make the product durable and short cuts that save labor never dreamed of by his fellows, who gave only part of their time to the service and tried to do many others simultaneously, for some of which they were probably unfitted either by reason of eyesight, or some peculiarity of mind, hand, or body.

But now a new question arises. On what basis shall these exchanges of service and produce be arranged? The simplest way is for each to give what he makes and the other wants. One villager exchanges so much meat and raw hide for so many pairs of moccasins and shirts — or meat for fish, or fish for corn. And the amount given in each transaction will depend upon the elemental laws of supply and demand.

"I have a haunch of venison to spare," says the hunter. "I need a basket of corn. You have corn to spare; you need meat. Let us exchange."

Thus business is born. Each villager gets more and better meat, corn, fish, clothing, and protection than under the less economical methods that were formerly used.

And now a new problem confronts our village. What way can be found measuring the values of the different services rendered by its different inhabitants? In primitive days it was the practice to take some article of general use and measure values with it. Corn had many advantages and was sometimes used. Skins were valued at so many measures of corn, and so was salt, and so was meat or fish. Corn is an imperfect medium of exchange, varying in value in years of good and poor crops, awkward in its bulk and perishable, but useful in that it is of universal use, always in demand, and always of value. Thus the idea of money comes to us — and little by little there was created a system of currency based on valuable metals held to uniform value as nearly as human ingenuity could arrange.

And now we come to a new phase and aspect of business. One member of our community develops more foresight than others and foresees a year of poor crops. So instead of planting corn enough for one year's use only, as had been the practice, he plants three times as much corn as before

and builds a place in which to store it — and lo! the capitalist is created. He finds he can use the corn to buy more skins, more meat, more fish, and at the same time, when the year of shortage comes, he finds himself in position to be a public benefactor by saving his community from hunger. These simple transactions are all business, and if the game is played fairly they are all beneficial; every one gains by them, no one loses.

One way of estimating the value of the service to the community is to measure these activities by the length of time it takes to produce each commodity. We will suppose, where each family provides everything for itself, that all the members work all the time without rest or let-up and get a small amount of poor quality of each thing which they use; in other words, live the lives of savages. By specializing each member produces more and better quality with less labor, and the second step finds us with a community in which the people enjoy better living conditions all around and do not have to work as many hours. The time spent in each service, however, is not in any sense a true measure

of value, unless the services are classified. Some services are extra-hazardous and therefore are much more highly paid, and services of responsibility have to be more highly paid than services that require less power of management.

Let us carry our illustrations a little further. We will suppose that one man more ingenious than the others builds a water-wheel by which he converts the movement of the river into physical energy and devises a method of grinding corn. This works nicely in times of freshet; but there is not always a freshet when the corn is to be ground, and he devises the plan of building a dam across the river to divert the waters to his wheel. But he finds that the rocks small enough for him to move won't resist the rush of the water and his dam is swept away. Then he calls in his neighbors, and among them, by united effort, they build a dam that serves the purpose, and the miller finds that he not only can do the work that was done formerly by several hundred people, and grind corn for the people in his immediate vicinity and do it better, but also

that by working his mill day and night he can grind corn for many neighboring communities. The idea soon occurs to him that he will take a certain percentage of the corn he grinds as his pay, and people come in with sacks of corn on their backs and go out with so many measures of meal, the miller reserving two measures out of every five, or three out of every eight, as his proportion. Others, however, have an interest in his enterprise; they helped to build the dam. Perhaps he has given them some privilege: he takes only one measure out of eight from those who helped him build the dam; they get a larger return in meal for the corn they bring in. These are shareholders and their larger proportion of corn meal serves as a dividend. Where this is done on a larger scale, the modern practice is to organize a corporation, but the underlying principle is exactly the same.

Let us now turn our attention to an aspect of business that will, if clearly understood, help us to understand many of its advantages and uses — to see more clearly the service it can render. Our village is situated

on the bank of a river — a river that rises and falls in time of freshet and drought, so that to be safe the houses must be well back from the stream. Every day the women and children have to walk to the river for the water for cooking and washing purposes and carry back the pails full. This is a serious burden, and often the little children or frail women strain themselves lifting their heavy burden up the steep banks and away over the fields to their homes. One result is that they use much less water than they should and their houses are not as clean and consequently not as healthy as they would be were it easier to get water. Our ingenious man begins to think about this, and presently he builds a little dam on the hillside, and by means of little ditches, paved to prevent washing away, carries a supply of water to the very doors of all the houses in the village. Ravines are crossed by aqueducts made from the trunk of a tree scooped to make a runway for the water.

Let us see the permanent advantage that the builder of the dam has given the community. Suppose there are forty families,

and each family spent, before, an average of one half-hour per day of one person fetching water. Putting this service all together it means the equivalent of twenty hours' work of one person each day and in a year over seven thousand hours of work. The new waterworks, we will say, cost the equivalent of one month's work of twenty men, working eight hours each day, or we'll say, forty-eight hundred hours. It is easy to see what a saving this work will prove to have been in ten years. In less than a year the whole time spent on the construction has been saved, and from then on over seven thousand hours of work a year are saved. Besides all this, each house has more water and there is an additional advantage by reason of the cleanliness and health that ensue.

An illustration of this kind ought to put a stop to the silly argument, sometimes presented even to-day by an occasional less intelligent agitator, that machinery puts people out of work and therefore brings harm to the community. That sort of person should be given a penknife with which to cut down

an oak tree and be denied the use of an axe on the ground that the axe would make less work for him to do.

And now let us go back to our village and carry our illustration further and assume a new development. One village discovers that copper is to be recovered from the rocks; down the river at the mouth there is a village where the people know how to make salt from the sea. A third community has learned to build canoes that can navigate the rivers and carry salt in and copper out, and the inland people want salt and the seashore people want copper, so that the business of transporting these commodities makes enough profit for those who operate boats to enable them to devote themselves exclusively to this trade and produce no merchandise for sale. Thus commerce grows — and, looked at thus simply, it is all service.

Now let us study a new aspect of it. Some services, like those of hunting, putting out to sea for fish in frail craft, or doing duty in arms to protect the tribe from attack, prove to be much more hazardous than others, and the huntsmen, fishermen, and warriors lose

their lives oftener than do those engaged in agriculture, mining, milling, or making of garments. The former say it is not fair, and when they die their women and children suffer. It is necessary to pay more for this kind of service, but those engaged in it are uneasy in their minds. One of them devises a plan whereby a portion of the earnings of all of them is laid aside in a fund to be used by the headmen of the village to support the families of those who are killed. This has finally developed into many kinds of insurance against accident, fire, theft, and so on, that to-day give a sense of security to millions of workers and their wives and families, and also to investors, trustees, and tradesmen, and employment to so many thousands of our fellow citizens.

Following along these fundamental principles, one can very easily trace them through to the immense complexity that the present world presents to us of commerce, trade, finance, and other aspects of business. And in every case it will be seen that business is merely service. If some man more ingenious than others learns how to do things

that others have not done and thus saves their time, or improves their living conditions, he has performed a service. It does not matter whether the service is in studying the nature of soils, rotation of crops, selection of seeds, time and manner of planting, depth of ploughing, and all the things which make up successful agriculture; or whether it is in more skillful fashioning of the raw copper taken from the rocks in order to shape it into suitable vessels for cooking, or the making of other implements convenient for human use; or in the manner of mining iron and manufacturing and hardening it into steel; or teaching the making of clothes, designing new styles of houses, supplying food as do the grocer and butcher, spiritual health as in the case of the minister, education as in the case of the teacher, beautiful objects to look at as in the case of the painter, sculptor, or florist, pleasant reading as in the case of the novelist, or ways of getting about as in the case of the manufacturers of automobiles and the operators of railroads or of steamship lines.

If every man engaged in every kind of

business were imbued with the spirit of service and had grasped the elemental fact that underlies all transactions, namely, that a trade is a good trade only if it is good to both parties, I feel sure there would be less misunderstanding and criticism of business as such. The trouble is that people get so one-sided in their point of view that they cannot see things fairly, and as a result there are no doubt many unfair transactions resulting in disagreement, lawsuits, injunctions, strikes, and often violence.

Capital and labor are one, and, as capital is the direct product or offspring of labor, may be said to be the same thing. Their interests are identical. Everything that hurts capital hurts labor; everything that hurts labor hurts capital. Capital is nothing more nor less than accumulated or stored-up labor — labor put in permanent and lasting form, as seen in our illustration of the village waterworks. If through any misunderstanding any capital is destroyed, labor is directly the sufferer. In the first place, some of its permanence is taken away; labor has lost one of its valuable qualities; it is made

less durable and therefore less effective. Secondly, the usual use of capital is to make labor more effective by providing machinery which enables labor to produce more, or by making living conditions more favorable, as for example in the construction, as we have seen, of waterworks, and, in modern communities, hospitals, libraries, schools, and so forth, and by providing funds from which insurance can be paid, and in a thousand other ways too numerous to mention. The fact is that most conflicts between buyer and seller, employer and employee, capital and labor, or between litigants, are due to the failure of one or both parties to realize that their interests are and ought to be one and the same, and that their only effort should be to find the thing that is really equitable.

I have said that business is service, and yet there are many abuses committed in the name of business which have gone a long way to give business the bad name which it undoubtedly has gained in many minds. These are due in part to abuses of power and in part to the improper action of unscrupulous persons who plot and conspire to

defraud the public of their savings. I will give some illustrations of this sort of thing to show where control should be exercised by the community in the interest of self-preservation.

This matter of control of capital and private property by the community is most difficult. That some control must be exercised is absolutely clear. As a matter of fact, the community exercises all sorts of control over our movements and activities in order to force a proper measure of coöperation. One cannot keep pigs in one's parlor or even in the house, much as one may wish to. We have to drive on certain sides of the street. We cannot even construct buildings on our own land just as we wish — we must conform to certain rules laid down by the fire department or the street department or the health department.

Let us see how one of our main difficulties arose in our elemental village community. Consider the case of the man who has laid by a store of corn, and who, when the year of famine comes, fails to rise to his opportunity to be a benefactor and, giving way to

greed, undertakes to squeeze his neighbors — to charge them unduly high prices for his corn and take advantage of the fact that, owing to lack of foresight, they are threatened with starvation, having failed to provide for the possibility of drought, locusts, or a damaging foray of the neighboring tribe. Suppose this person, seeing his neighbors about to starve, tries to exact from them the very last measure of everything they own. Of the fisherman he demands his nets, of the carpenter his tools, of the medicine man his herbs, and of the hunter his weapons. Perhaps he goes farther, as used to be the practice — and in some countries still is — and demands that the people give over their children that he may be supplied with slaves. He says, "You will pay me my price or you and your people will starve."

These extremes are all against the public interest, and sooner or later the public finds a way to protect itself against this sort of thing. Laws are passed, for example, that no man may have slaves. In time of general famine, a committee of public safety is

formed to take charge of all the food supply and to determine on what terms the people shall get it and how the former owners are to be reimbursed.

The village must take two precautions. The first is to see that the people are fed and do not have to cripple their future effectiveness in order to pay. For example, each citizen should be left with his tools; each man should have his means of livelihood; his power of rendering service should not be lessened; his children should not be given in bondage. And the second precaution is not to deprive the man of ingenuity and foresight of the fruits of his wisdom and energy, so that he will be encouraged to continue to exercise them and will not be so discouraged that he will move away or feel like sitting back and not putting himself out further to continue the profitable and intelligent development of business in his neighborhood.

Here is another example of abuse that needs remedy. Let us imagine a railroad controlled by a few unscrupulous persons who own a coal mine or group of mines in the region served by the railroad. And we

will suppose these people, wishing to monopolize the market for coal in this region, refuse to carry the coal of rival companies or charge a rate for hauling their coal which makes the cost of delivering so high that they cannot successfully compete. It was early seen that this sort of thing was disadvantageous, and laws were passed making railroads common carriers, which means that it is illegal for them to make such discriminations, and that if freight is offered, the railroad is compelled to accept and carry it at a rate fixed for that class of commodity.

Even more insidious might be the political control of a railroad and its use to further party politics. Every employee of such a line would be pretty sure to be a regular voter in the organization of the party in power, and it is not beyond the limits of imagination to find a situation in which the railroad facilities might be denied to men of the opposite party desiring to go to the polls, or it might happen that the train bearing the orators for an opposition meeting, or even the candidate, could be side-tracked till

after the time for the meeting had passed. Thus a common carrier might easily abuse its power and defeat the ends of democracy were it not for the laws which control its use.

An abuse in business which it is more difficult to control is connected with fraudulent companies, foisted on the public by unscrupulous promoters and brokers. Certain careful investors make a large profit in some legitimate business such as supplying the community with metals, oil, rubber, or irrigation. People hear of their successes, the papers are full of them, and as a result a lot of "mushroom" companies are formed and the stock is sold to "investors." By "mushroom" I refer to companies that are promoted without adequate values to justify them. It is a good rule to beware of investing in the stock of any company capitalized at a few cents or dollars a share, which advertises freely promises of large or quick dividends, and particularly those which advertise that after a certain date the price at which their shares are offered to the public will be advanced. These are usually indications of a desire to dupe people of

small means inexperienced in matters of finance. Such enterprises are in their essence culpable and should be prohibited by law, if a law can be devised that will separate the sheep from the goats, and not discourage legitimate enterprises.

It is not possible that all businesses should be successful. Human intelligence is in the nature of things fallible, and even the wisest business men make mistakes and often in the most promising-looking ventures. The ideal rule for every man to follow is to play very safe and never to invest in a new venture beyond what he can afford to lose; and those of small means should not invest in any except the safest things, such as companies showing established earnings over a protracted period of time, deposits in savings banks, and government securities.

There is no need of explaining further the essence of business, for the mind runs easily and naturally along the lines laid out to our present system of inter-relationship. With no change in principle whatever, we have reached a situation where the forces that fill

the daily needs of even the most humble of us are far beyond the knowledge of even the best informed. A man must be expert in a hundred different ways to know the life-history of the articles of daily use in every home in the land. Some people think there is no romance in business. Why, the romance that surrounds the business of supplying even the simplest needs of an average American citizen would make the great romances of history pale into insignificance in comparison. It is not that the romance is not there, — it is only that we do not see it. The things we use most often, such as sugar, or coffee, or cereals, the materials that make up our articles of wear and use, our clothes, shoes, toothbrushes, soap, ties, knives, and even the coins in our pockets, as will be seen in later articles in this series, are the combined product of the brains of thousands of wise men, living and dead. They are the product also of the hands of further hundreds of thousands of men whose labor is not all that of to-day, but in part the stored-up labor of men lying dead. Whether this brain and hand labor is

represented by the lighthouse that saves a ship from wreck, the dock to which it swings in, the tunnel through the mountains that the train comes through, the warehouse, the lorry, the elevator, or the kitchen stove — it has performed its part in the making of something that you use to-day with a bored complacency which ignores the great forces working endlessly and tirelessly for your comfort and happiness.

Kipling has told of it in his poem called "The Miracles." Let's hear a few of his words:

> Earth sold her chosen men of strength;
>   They lived and strove and died for me,
> To drive my road a nation's length,
>   And toss the miles aside for me.
>
> I snatched their toil to serve my needs,
>   Too slow their fleetest flew for me;
> I tired twenty smoking steeds,
>   And bade them bait a new for me.

He certainly saw the romance in the great smoking locomotive that puffed and panted to draw his train at hitherto unheard-of speeds to help him in his quest. Read also in his poem "The King":

And all unseen
Romance brought up the nine-fifteen.
His hand was on the lever laid;
His oil can soothed the worrying cranks;
His whistle waked the snowbound grade;
His fog horn cut the reeking Banks.

II

AS WE ENCOUNTER IT AT THE BREAKFAST TABLE

I HAVE spoken of the romance of business which concerns our daily life, so hidden that many of us do not realize that it is there, and none of us can know it in its entirety, as it is beyond our power of comprehension. I can illustrate my point only by following through to their origin some of the things of commonest daily use and by showing how interesting a history may attach to them and how varied are the forces that brought them about. An exhaustive study of the things we use even in the beginning of the day would lead us inevitably through the whole progress of the human race — production, machinery, transportation, health, science, chemistry, invention, social order, government, and so on.

We come to the breakfast table. We are so accustomed to seeing the implements of household use on it that we accept them

without thinking. There are the plates and cups and saucers. They are made of china. Does the name convey anything to us? We are so used to speaking of these things as china that we have to shake ourselves a moment to realize that the word China carries another and older meaning — a land of vast population, yellow skins, almond-shaped, sloping eyes, pigtails worn by men, silks, teas, mystery, philosophy, and the oldest civilization in the world, with the most substantial traditions. That the name is the same is no mere coincidence.

The porcelain ware that the ships of the seventeenth century brought from the Far East was called Chinaware, from the country whence it came, because it was unlike the pottery made in Europe at that time. Chinaware, now shortened to "china," recalls early exploration voyages, in small craft with high poops, to a land of a thousand mysteries and legends, and the later trading voyages in swift-sailing clipper ships, manned by rough-and-ready seamen. Imagine the ship returning to some English port, the men displaying their novel wares

to a wondering audience and telling stories stranger even than the thin, beautiful cups and saucers from the Flowery Kingdom.

Our china, no matter how beautiful, is made principally from clay. Wherever men found clay, they became potters. For centuries they hardened their simple, handmade vessels by drying them in the sun, but presently they learned that clay baked by fire would become almost as hard as stone; and still later, learning that different clays, when baked, assumed different colors, they ornamented their work.

The earlier processes were much the same in Egypt, Greece, and China. As the art grew, the Egyptians worked with bright colors, the Greeks mastered form, and the Romans spread the knowledge that they inherited. But all the time the Chinese, working on their own lines, were learning more and more of the processes that have given them their reputation as the greatest of potters, until from their fires came the wonderful porcelain that amazed mediæval Europe.

We still look to foreign countries for much

of our china, and import our dishes from England, France, and Germany, as well as from the Far East.

Here beside our plates on the table are the silver forks and spoons. When did they come into general use? How does it happen that we do not use chopsticks like the Oriental, or our fingers — as many of the poorer people in the Philippines and other countries do to this day? How many of us know that forks and spoons came into general use only about three hundred and fifty years ago?

And then how are they made? They look like solid silver, but they may be plated. Think of the ingenuity exercised in developing the process of dissolving metal in acid and then causing it by electricity to be deposited evenly over the surface of another metal. Solid silver or plated, there are marvelous tales of adventure, of escapes, of sacrifice, of enterprise, or perhaps even of crime, connected with the business of supplying the world with silver, whether it is mining the ore deep in the bowels of the earth, or treating it in little crucibles or in

vast smelters, or transporting it. Perhaps the metal for the fork that you hold so casually in your hand came from the heights of the Andes in Bolivia, or from the blood-stained mines of Mexico, or from the fastnesses of our own Rockies. Silver can last many years. Who knows but that the plating on the spoon you pick up in the railroad restaurant was once part of buried treasure like that of Captain Kidd, or perhaps taken by Drake from the Spaniards, who in turn had wrested it from the peons of Mexico, sweating under the cruel lash and dying in droves unrequited for their services.

Perhaps we begin our breakfast with a cup of cocoa. This cocoa bean from which our dish is concocted may have come from places as widely separated as Ecuador, Trinidad, Africa, Venezuela, Granada, Hayti, Cuba, Ceylon, Para, Bahia, Surinam, Martinique, Guadeloupe, Java, Dominica, St. Lucia, and Jamaica. The vanilla flavoring comes from Mexico. If it is to be sweetened chocolate, a certain amount of pulverized sugar is added. By skillful blending of all these products the manufac-

turer gives the finished cocoa or chocolate its individual flavor.

The best results are obtained from a blend of different beans, so that the cocoa that we sip so casually at our table is the result of the efforts of widely scattered and far different peoples. Perhaps some of it is grown in a Central American republic; here we might come in contact with rapidly changing governments, a place in which the planters do not know from day to day whether they are to be left with their property or not. Revolution is rife, and the question of which group happens to be in the ascendant in this or that district is to the planter a matter of life or death, success or ruin. He may have to rush his product out and accept his pay in some distant bank in Paris, London, or New York, and bring to his own country only enough money for his pay-roll and his living expenses, lest his government seize his bank balance.

Perhaps the cocoa beans came from the orderly and well-governed British colony of Trinidad, where the native population has been largely augmented by Hindus brought

from India, and where the great asphalt lakes are to be found. One of these lakes that I have visited presents a hard asphalt floor; but if you take a pick and dig out a cart-load, lo, in a while the hole is filled. In some places the asphalt is hot and bubbles up, and if one stands on these places he will soon sink in. But this is not a story of asphalt, though that may be appropriate later in the day, when we start to walk to school or to the office.

The cocoa bean is a small brown affair, about as big as a joint of your little finger, and very bitter. How long ago was it discovered that this bean, when cooked and sweetened, became very palatable and nourishing? The early history of cocoa is found in ancient stories, mixtures of truth and legend, told by travelers. Cocoa came originally from the country along the tributary streams of the Amazon, where it is still found in abundance. But from the Amazon country it has spread to Central America, the West and East Indies, Asia, Africa, and Australia, and our own most southern States.

"The chief use of this cocoa," one

Josephus Acosta wrote in 1604, "is in a drincke which they call chocholate, whereof they make great account, foolishly and without reason; for it is loathesome to such as are not acquainted with it, having a skumme or frothe that is very unpleasant to taste, if they be not well conceited thereof. Yet it is a drincke very much esteemed among the Indians whereof they feast noble men as they passe through their country. The Spaniards, both men and women, that are accustomed to the country are very greedy of this chocolate. They say they make divers sortes of it, some hote, some colde; yea, they make paste thereof, the which they say is good for the stomache, and against the catarre."

Another early quarto condemned it because of the great quantity of sugar that people mixed with it, but admitted that it had a wonderful faculty "of quenching thirst, allaying hectic heats, of nourishing and fattening the body." As late as the eighteenth century theological writers gravely argued whether it was necessary to fast from chocolate in Lent.

The fascinating history of cocoa carries us back to the days of the early Spanish and Portuguese adventurers and explorers and, in the western hemisphere, long before them. We learn of groves of saplings so sensitive that they must be planted in the shelter of larger trees, tended with the utmost care, and protected from monkeys, squirrels, and deer, which delight to feed on the fresh tender leaves, and from parrots, which alight in flocks and destroy the valuable seed pods. We must watch swarthy workmen who cut down the pods with knives mounted on long poles not unlike those used in the North to gather spruce gum; native women who pile the harvested pods; men with cutlasses to break the pods and women with wooden spoons to remove and clean the beans; and various processes of sweating and rubbing and drying and cleaning and blending and roasting and crushing.

That cup of cocoa on our breakfast table, if it makes us stop and think, will take us in imagination hundreds of years into the past; it will conjure up for us a whole history of manufacturing from the crude methods

and implements of primitive people to the complex, wonderful machinery of a modern factory; it will bring us into the company of ancient explorers, merchants, innkeepers, philosophers, kings, and prelates—and some of the up-to-date and able business men of the twentieth century.

In the Philippines there are no great groves of "cacao," as the Spaniards call the product, but many trees are to be seen in the yards of the houses, and though the Islands produce little or none for export, I have often drunk cups of the home-made product. The tree is subject to many blights and diseases and it takes constant and scrupulous care. But in Central American countries thousands of acres are set out to the trees. The beans are gathered, dried, and sorted, and then shipped to the central markets, where the merchants store or ship them to the companies engaged in making the finished product which, when cooked and sweetened, we call chocolate and use either for food or for making candy, as we please.

Our cocoa has a little flavor of vanilla,

which comes from the fermented and dried pods of several species of orchids. The great bulk of commercial vanilla is produced from a plant native to southeastern Mexico, which is now cultivated in various tropical countries. The Aztecs of Mexico used it as an ingredient in manufacturing chocolate before the Spaniards, who adopted its use, discovered America, and as early as the sixteenth century it was used thus in Spain.

Some vanilla beans that came into the hands of Hugh Morgan, pharmacist to Queen Elizabeth, were regarded as a great mystery, for no one knew what plant bore them, and they went by the formidable name of *Lobus oblongus aromaticus*. But before that vanilla was regarded in Europe as a medicine of great power and various writers attributed to it absurd cures.

The art of so curing the vanilla pods as to keep all the richness and sweetness is long and difficult. In the primitive process that the Mexicans used, the fruit was piled in heaps to ferment, rubbed with oil of anacardium, then dried and oiled again. In the modern process the pods are cured by

a seemingly endless course of sweating and drying which requires a high degree of skill and care. But to realize how well worth while is the expenditure of labor, it is necessary only to consider the price which vanilla commands — five dollars a quart — and the variety of foods in which it has come to play a well-nigh essential part. We use it in an almost endless variety of sauces, puddings, cakes, candies, and ices.

Are we to add sugar to the cup of cocoa? Let us look at this little white lump we pick from the bowl. There is nothing about it to tell whether it came from the great, waving, emerald-hued fields of Cuba or Porto Rico, or all the way across the Pacific and through the Panama Canal from the Sandwich Islands or even from the Philippines; whether the land that raised it got moisture by irrigation from the mountains behind Honolulu or sought its warmth from the rays of the sun over the island of Negros where most of the Philippine sugar is raised. Perhaps it came from Louisiana, where the semi-liberated negro works in the cane-fields by the great lines of levees on the Mississippi.

Or is it beet sugar? Perhaps it was derived from the boundless prairies of our own West irrigated for sugar production. The water is impounded in the hills and is diverted from the mountain streams and led through ditches to the level plains to supply the moisture necessary for agriculture. In this region the rainfall is only thirteen to fourteen inches a year — which is very little compared with the excessive rainfall in some of the cane-producing countries. In the Philippines it runs as high as one hundred and fifty to two hundred and fifty inches. How our arid deserts would spring into blossom and produce if they could get a small fraction of the excess rainfall of the tropics, as in Panama or the mountain slopes of Luzon!

Wherever our cane sugar comes from, we know some of the processes by which it is produced. It is probably hauled in bull-carts from where it lies in the field to the little narrow-gauge railroad; then puffed by a diminutive engine to the mill, where the great mechanical lifters take a carload at a time and put it on a traveler, which by means of an endless chain carries it relent-

lessly to the crushers. There it is squeezed and the juice is caught and taken through a variety of processes — heating, cleaning, and so on, — until out it pours, a moist, sticky, golden-brown stream, which is caught in bags of burlap, automatically weighed and laid in the storehouse awaiting shipment to the refinery in the States. The waste product of the cane, called *bagasse*, a stringy, pulpy, straw-colored substance, can be made into cheap paper, or, as is most often the case, is burned as fuel and makes the power that operates the mill.

The sugar is brought from the tropics in the raw state to the refineries, which are located in the great seaport towns. Here it goes through a complicated process which includes washing, melting, precipitating the insoluble impurities, filtering, crystallizing, drying, sorting the crystals, and finally packing them in containers of various sizes. In addition to the huge buildings where the sugar goes through the manufacturing processes, the typical refinery includes offices, shops, laboratories, and immense warehouses. The wharves and docks are scenes

of more than ordinary interest. A great number of men are at work hoisting, trucking, sampling, and piling the bags of sugar; and then there are the sailors from the four corners of the world: Hawaiians, soft of speech and born with a love for the salt sea and for the plaintive music of their native land; sullen Malays; short, keen-eyed Filipinos; and men of an indefinite nationality who look as if they might be descendants of the buccaneers who ravaged the Spanish Main. These are the sailors who bring the sugar to the refineries.

Some of the larger plants refine two or three million pounds of sugar in a day and employ as many as twenty-five hundred men, and are so highly developed that from every one hundred pounds of raw material they are able to manufacture about ninety-three pounds of the purest granulated sugar.

The life-history of sugar is as appealing to the imagination as a tale from the Arabian Nights. On its long journey from the cane- and beet-fields to our table it is handled by huge and marvelous machines, the products of thousands of ingenious minds, and at

every turn some new miracle is performed to bring it one step farther toward its final perfection. If Aladdin had rubbed his lamp and summoned the genie to perform the miracles which our factories are performing daily for us in extracting the boundless sweetness from the earth's vegetation, and presenting it in palatable form to so many hundred million people, how extravagant a request for something impossible of achievement it would have seemed to readers of the tale living even as late as one hundred years ago!

So much for our cocoa and its sweetening. But perhaps it is coffee we drink, and here again another series of pictures comes to those who have seen these things in the making. Imagine Brazil, greater than all of Europe in area, with uplands in the tropics and mile after mile of hilly country, many of the hillsides being covered with coffee trees. They are not planted in the valleys, which make pockets that catch the cold night air that would injure the trees; but on the slopes they are to be seen in orderly rows, their glossy leaves shining in the bright sunlight

and the green berries waiting the proper moment to be picked, dried, packed, and shipped to gratify the appetites of a waiting world.

But it may be ours is not Brazilian coffee. Perhaps it comes from Guatemala, where the native Indian women, broad-shouldered and strong, come running in, mile after mile, with a long, steady stride, bearing on their backs huge packs of produce for sale in the cities.

It is probably not Philippine coffee. There the typhoons are so terrible that coffee planters have been greatly discouraged, and some years ago a blight came that destroyed all the plantations in one province and most of the wealth of the people of that region. But the quality of the coffee bean in the hills of the Philippines, as grown by the savages in little clusters of trees near their houses, is such that the Chinese traders come and buy it and ship it direct to Paris, where they are always on the lookout for a superior article. And so Americans get very little of the Philippine coffee.

If the morning cup is tea, we must go

overseas on another long expedition and look over the tea-growing countries, perhaps in the mountains of Formosa, now owned by Japan, or the great plantations in Ceylon, or the slopes of the Himalayas in India near Darjeeling. We might trace the history of that industry and follow the growth of the commercial houses that dealt with China, with all the romance of the clipper ships racing home with cargoes of tea and silk, or the later procession of vast steamers plying the waters of the Pacific, a sea which lives up to its name and lies placid until such time as one of the raging tropical typhoons arises to awaken it to a violence as terrible as its peaceful surface was calm.

But time presses and we have not got very far with our breakfast. We help ourselves to bread and butter, and now let us pause to conjure up something of their story. Once more we must go to our wonderful West. We must picture the pioneer pushing the bison and elk, antelope and deer from the plains, and later the lines of rails stretching out ever westward, and these followed first by cattlemen, then by small farmers, and then, a

later development, by the great tractor engines ploughing miles and miles of prairie. We must learn the winning of the West, and accustom our eyes to the wheat-fields with their miles-long furrows. A tractor can pull the equivalent of thousands of pounds; with one man at its wheel it can operate not one plough alone, but many. It can pull out brush and boulders, uproot hedges, stumps, and trees, plough, list, disk, harrow, drill, roll, pack, spread fertilizing material, plant, haul crops, move houses, bale hay, shell corn, grind fuel, saw wood, load logs, pull mowers, push harvesters, and break up ice in the streets. The story is told of a Western village whose citizens, mindful of Mohammed, hitched tractors to their houses and public buildings and literally moved the entire town across the prairie to a railroad.

The story of the tractor is of the twentieth century, and in its first suggestion it is associated with our Western plains, where modern machinery has made it possible to farm on a gigantic scale. Its fascination is very different from that we have seen in the history of cocoa, for example, or in those

spices which are so intimately associated with the story of our own early merchant marine. Rather it is akin to the romance of ocean liners, freighters trim in black paint and polished metal, locomotives thundering across the continent between the fields of wheat and of corn.

Have you read "Calumet K"? Get it and read it. It is the story of how a hustling American foreman got his job done on time against staggering odds. It tells vividly the working of the great grain elevators and tells it in such a way that, though I have read the book over and over, I can hardly put it down even now till I have read it through again. In that story you can get some of the flavor of romance that goes into the business of getting each day our daily bread.

Where is the butter from? Have you ever visited the Channel Islands? They are called Jersey, Guernsey, Alderney, and Sark, and comprise an area of seventy-five square miles, a trifle more than one sixteenth of the area of Rhode Island. And in this diminutive area were developed those wonderful herds of cows, the progenitors of those which

play so important a part in the supplying of milk, cream, and butter for our daily use, so necessary for the health and growth of our children.

We have also to thank other agencies than cows for much that we eat as butter. There are many substitutes, and one of the commonest comes from the dried meat of the cocoanut, which has nothing whatever to do with cocoa, or cacao, from which chocolate is made. The cocoanut tree is a palm and a beautiful thing to see. It grows in tropical countries near the sea — and what could be more exquisite than the leaves of the waving palms, seen as I have often seen them, against the sun and with the sea shining behind them? As you get under them you find the great mass of cocoanuts clinging to the stem near the base of the branches or fronds. The nuts are in various stages of growth. The full-grown ones reach the size, husk and all, of a man's head, and before ripening contain a fluid called milk, although it is only partially whitish in color, clear and slightly acid to taste, and very satisfying to the thirst. We all know the taste of cocoa-

nut; it is often found in cakes, confections, candies, and desserts; but how many of us know that the meat of the nut, when dried, is shipped to factories and refined into oils and other materials from which soaps and substitutes for butter are made?

The next thing at breakfast is an egg. Perhaps this was laid in our own barn or shed. The hen is descended from a wild fowl through I do not know how many centuries. The original bird in a wild state is called the jungle-fowl and is found in abundance in the Philippines. It is a curious thing there in the middle of the dense jungle, far away from any habitation of any sort, to hear cocks crowing all about in the woods. It is difficult not to believe that a farm is near. I remember once, on a shooting trip, standing on a little island in a small river, while the native beaters came nearer and nearer, and presently a magnificent cock with wickedly sharp spurs on his legs flew by and, luck being with me, fell at the first barrel. I have him stuffed at home now. Leghorn roosters are very similar in size and coloring. By careful selection and breeding, men have

created dozens of distinct breeds, some of great, some of little size, some good for eggs, some for meat. Go to a poultry show and your eyes will open with wonder at the results, but even this will tell little of the labor, thought, and care that brought about these results and the centuries through which they have been operating.

Our bacon brings us to a new line of study, large enough for a whole shelf of books, all dealing with various aspects of the life-history of the domestic pig. Here again we may be taken overseas, perhaps as far as Brazil, where there is now being developed a pig-raising country that bids fair to rival the best to be found anywhere.

In the United States alone in the fiscal year of 1919 nearly 44,400,000 hogs were slaughtered under Federal inspection. Before their transformation into pork, the hogs are well rested and given a shower bath. Within twenty minutes after the hogs are dispatched, the carcasses have been dressed and run into cooling-rooms, where they remain two days before cutting takes place. The best flanks, carefully trimmed, are se-

lected for bacon. These are cured with sugar, salt, and saltpetre, and are then smoked. In a single year the curing of ham and bacon in one of the five large plants requires more than 113,000 tons of salt and 1400 tons of sugar. The smoking consumes over 8000 cords of hickory wood. The scientific, modern methods of dressing, curing, smoking, slicing, and packing breakfast-table bacon are the results of years of experiment and study.

The products recovered from the hog range from bacon to bristles and from ham to pigskin. And besides the story of bacon a study of the packing industry will give us many side histories; the football that is carried across the goal line for the winning score in a university game, the traveling bag with which the porter runs down the platform of the Grand Central Station, the great kettle of lard in which the cook in a lumber camp of Maine or Michigan or Oregon fries doughnuts by the hundreds, the stiff brush in a harness shop, the ham sandwiches on the lunch counters are all a part of it.

In one large Chicago plant seven thousand workers prepare daily enough cattle, sheep, and hogs to form a line of animals twenty miles long. The products of numberless businesses, many of them seemingly far removed from the packing industry, are assembled in enormous quantities to provide the machinery and equipment, the materials and the sanitary precautions necessary in the making of clean, wholesome bacon.

The time has come to stop. If I have not proved my point and given some idea of the romantic possibilities of our day's supply of common things, I cannot do it by going further. Everything we use, from our clothes to our pocket-knives, has its story, and most of them have many stories. If one can tell of interesting things that happened to inanimate objects such as forks or butter plates, think how much more our interest could be piqued if we could get for a minute in touch with the lives of the people who did the work! How long ago were the plates made? Who conceived the idea that changed this bit of clay and other mineral substances to this useful and convenient

form and substance? How did they learn so to mix the paint with which it is colored that it will last while many generations of men live and die?

What a mine of hidden or lost romance lies about us!

III

THE STORY OF TEXTILES

In the first chapter we drew a picture of a village in which every one did all his own work, and in that picture we indicated the saving brought about by specialization. In the second chapter we spoke of the romance of business as encountered at the breakfast table and showed how a study of the things we use at the beginning of the day leads us inevitably through the whole progress of the human race. It is the object of this chapter to trace some of the developments in the production of the things we wear.

We know that very early in the history of civilization fabrics came into common use. Skins and furs were perhaps more easily come by, but the process of extracting fiber must have begun early. Fibers are found in much vegetable and animal growth. Probably the first cloth was made in the homes by the women and perhaps by older children in their less busy hours. Go to the moun-

tains of the Philippine Islands and observe the primitive peoples there. One can see the process still going on, for looms are part of the equipment of almost every household. By means of thin bamboo pedals women raise and lower the two frames, alternately displacing the two sets of threads and leaving a space for the shuttle to pass through. A thick pedal raises two parallel sticks inserted between the sets of threads while the women sit at the loom and cast to and fro the shuttle that weaves the cloth.

Even though the practice of making cloth by hand has largely gone out in our country owing to the greater effectiveness of machinery, the prototype still survives in our homes, for one sees women everywhere engaged in knitting or embroidering, or practicing other of the gentler arts that result in the production of fabrics.

Wool, of course, comes quickly to mind, and the idea of annually clipping the sheep of his surplus growth of wool and working the product into cloth antedates history.

Wool as representative of standard value has become a byword in the phrase, "All

wool and a yard wide," a homely proverb. But as you test a sample of cloth by crushing it in your hand and watching it spring back again when you throw it down, or as you hold a few threads over a lighted match and watch them crinkle up while you sniff the familiar smell, you are not likely to think of the part that wool has played in history or of the fascination of the story of the growth of the industry. In the Book of Genesis, even before Judah went up unto his sheep-shearers to Timnath to shear his sheep, allusion bears out the antiquity of the woolen industry.

The Greeks and the Egyptians contend for the honor of first manufacturing woolen cloth, but before history began wool was one of the commodities used by our barbaric ancestors. Wherever traces of prehistoric man are found, there also are found traces of his sheep. Woolen stuffs have survived the centuries among the relics of the lake dwellers; bodies wrapped in woolen cloths are found among the burrows of the early Britons. Throughout the history of Greece and Rome sheep-raising was one of the

leading occupations and thence through the Dark Ages, through the Renaissance, through all the splendid mercantile adventures of the late sixteenth and early seventeenth centuries, straight down to the rise of cotton manufacturing, wool was the principal staple in the commerce of the world.

The importance of the woolen industry is reflected a thousand times in the world's great books. Homer and Virgil, among others, bear witness to the importance of the woolen industry in the lives of Greeks and Romans over widely separated periods.

In the ballad of Horatius, Macaulay wrote:

> The harvests of Arretium,
> This year, old men shall reap;
> This year, young boys in Umbro
> Shall plunge the struggling sheep;

linking thus the literature of ancient and modern times and introducing a reference familiar to the people of both. Nor is the interesting story of wool concerned merely with its antiquity and with the part that it has played in literature, from Odysseus and his adventures with that one-eyed shepherd, Polyphemus, down to modern times. In

the sounds of spinning-wheel and household loom you can hear the story of the struggles of our own thirteen colonies, of the early days of the Republic when in log cabins we were rearing the frontiersmen who were to fight the battles of advancing civilization, and of our Southern mountaineers of to-day whose homespun cloth even now is carrying tradition along, and this is further illustrated by the use of the trade name "Homespun" to describe goods that resemble those that were spun at the spinning-wheel. The very woolens that you glance at in a shop window may come from distant continents and remote mountain passes. The alpaca, the llama, the angora goat, and the camel each yields a sort of wool, and the cashmere goat of the Himalaya Mountains yields the most costly wool in the world. Where thousands of years ago the boy David tended his father's sheep in the land of Israel, swarthy boys are tending their fathers' sheep to-day. In the Eastern twilight, where a man can

> Plunge his hands to the mid-wrist deep
> In the cinnamon stew of the fat-tailed sheep,

there still are caravans laden with bales of rugs woven painstakingly, knot by knot, of wool. To this very day bright blankets are woven by the Indians of our Western plains.

The story of wool was already old when the shepherds keeping their flocks on the hills saw the bright star over Bethlehem. And yet it is still young in our factories, where machinery, seemingly endowed with almost human intelligence, turns out cloth on a scale that would have challenged the credulity of our ancestors of a mere century and a half ago, had any Mother Shipton or Moll Pitcher then foretold it.

The difference between wool and hair lies in the fineness and softness and waved delicacy of the woolen fibers, and in their highly serrated surface. From the farms and plains and hillsides, where men and dogs protect the flocks against every kind of marauding beast of prey, from bears and wolves to thieves that walk on two feet, the fleeces come to the mills in bags and bales, full of grease and dirt and burrs. In quality they vary from the finest Saxony, with as many as twenty-eight hundred serrations in

an inch, to inferior wools with as few as five hundred serrations. In each fleece there are six or eight qualities to be sorted out by skilled workmen.

The business of supplying our woolen wear has given employment to a great variety of specialists as it passes through the many processes necessary for its preparation. The sorted wool is scoured to cleanse it of the yolk — a greasy secretion from the skin of the sheep — and whatever other dirt it has acquired; it is rinsed and dried, carded and dyed, gilled, combed and spun, woven, washed, and fulled, pressed, measured, weighed, rolled and tagged. And behold! the rough, dirty fleece that was sheared whole from the sheep has become a soft, firm fabric, ready for the cutting-table.

Only a little over three hundred years ago — so young, in the light of history, are our Western industries — the first sheep to be brought to America were landed at Jamestown, Virginia, and in 1643 the first fulling mill in the Western world was built. But by 1801, when our forefathers imported the first merinos, America was well provided

with flocks and the business of manufacturing woolen cloth was established.

To realize how amazingly it has grown, one has but to survey the activities of the American Woolen Company, which has become perhaps the largest manufacturer of worsteds and woolens in the world. It owns and operates some thirty-four mills fitted with the most up-to-date machinery. To its 30,000 employees it paid, as far back as 1910, $13,000,000 in wages and salaries. In a single year it makes 50,000,000 yards of woolen fabrics in more than 30,000 styles. It buys all its supplies directly from the producers and it has its own sales organization, which makes it independent of commission houses.

According to estimates made a few years ago, 913 establishments were engaged in manufacturing woolens and worsteds in the United States. They employed 5325 salaried officials and clerks and 162,914 wage-earners. They represented an investment of $415,465,000. They spent for materials $273,466,000, for salaries and wages $79,214,000, and for miscellaneous expenses

$21,347,000. Their manufactures were worth $146,360,000. The interest attaching to the story of so gigantic and far-reaching an industry is as absorbing as that of the Crusades.

We here get some measure of the specialization which our age has reached. There are 110,000,000 people in the United States and about 170,000 of them are engaged in the production of wool fabrics. That is to say, seventeen of every eleven thousand people here are employed in the manufacturing of the wool they wear. But some of the woolen wear used in this country is imported — which means that people in other countries are also engaged in the work of supplying us. The exact number is not known, but even if it were as large as the number engaged in the work in the United States the total would be equivalent to only three or four persons out of every thousand. This can be compared with nearly half of the people working on the preparation of clothes in the early days when the women did all this work in our villages.

We cannot do more than sketch the story

of a few of the many fabrics that are in common use. Let us turn to the story of cotton, an important product of our own Southern States. Hemp and flax, the chief vegetable competitors of cotton, are long-fibered. Of the short vegetable fibers only cotton can be profitably spun into thread. The fibers of cotton, instead of being hollow cylinders as are other vegetable fibers, are flattened and twisted, and therefore hold together when they are spun, and thus make a strong, durable thread. Cotton is native to South America, Africa, Southern Asia, and the West Indies, but to-day more than half of the world's cotton is grown in the United States and most of the rest in India, China, Egypt, and Russia. It was first cultivated in India, but in spite of ideal conditions for producing it in large quantities, the crop for many years was small and of short staple, and was used only by local weavers to make the light clothing that the natives wear. Shortly after 1700 the West Indies, where long-staple cotton grows especially well, were supplying about seven tenths of the cotton for the Lancashire mills

in England. Attempts to produce cotton in the United States in colonial days failed, and toward the end of the eighteenth century, when we were exporting an amount equivalent to a few hundred bales, our American upland cotton still was of an inferior grade of short staple and uneven fiber which was hard to detach from the seed. The roller gin, the best that Southern planters then had, was of little use, and the work of pulling off the fibers by hand was expensive and tiresome.

Eli Whitney, a youth just out of Yale, was our ingenious man in the cotton industry. He devised a cylinder with fixed wire teeth to pull the seed from the fiber, adjusted a rotating brush to remove the fiber from the wire teeth, and revolutionized the business. This invention did more than any other one thing to give the United States its preëminence as a cotton-producing country. The Southern States largely abandoned iron, coal, corn, rice, and indigo, and set themselves to the task of raising cotton. In 1790 we raised 3138 five-hundred-pound bales. Twenty years later the output had

ELI WHITNEY WAS OUR INGENIOUS MAN IN THE COTTON INDUSTRY

leaped to 177,824 bales; a hundred years later, to 8,562,089 bales; and in 1917, to 11,302,375 bales.

Nor have we progressed in quantity alone. Upland cotton used to be regarded, as a matter of course, as short staple, but the demand for long staple led the growers in the upland districts to experiment until they produced cotton in large quantities of a staple length of one and one eighth inches and more.

The story of the cotton factories in its way is as engrossing as the story of the cotton-fields. The first factory was built of brick in Beverly, Massachusetts, in 1787–88, and failed because its machinery was so crude. Samuel Slater, well acquainted with the Arkwright machinery that was used in England, established a successful factory in Pawtucket, Rhode Island. From these beginnings the factories have grown until they reached in 1918 the tremendous total of 34,940,830 spindles.

This vast number of spindles operated by machines gives some idea of the specialization which has taken place in the cotton

industry, while the story of the development of our cotton industry reveals how small a part of our population it takes to prepare cotton, not only for our needs, but also for export to supply the needs in many other parts of the world.

Those whose measure of service consists of planting cotton embark upon one long campaign against difficulties. In early spring the land is prepared. It must be terraced, ditched, drained, ploughed, harrowed, and often planted by hand, although horse or tractor planters are proving of value. The season is long and the cultivation is intensive. Army worms, cutworms, locusts, green flies, leaf bugs, blister mites, boll weevils, and boll worms are often to be reckoned with. The plants are likely to shed their bolls. The cotton is for the most part picked by hand. It must be ginned, baled, shipped, compressed, and shipped again.

It comes, dusty and dirty, to the mills, where it is cleaned and put through various processes that continually lengthen and straighten the lap or sliver. It is spun, woven, singed, and bleached according to

the grade of cloth and the purpose for which it is made. It may be mercerized, dyed, or printed, and thus brought into the story that tells of modern chemistry and that part of it which has to do with dyes.

The mechanism through which cotton passes makes another interesting story. The "mule," a piece of machinery that both draws and spins, is an English invention and was used in preference to other contrivances both in Europe and in this country until the Civil War. Since then the ring spindle, invented by James Thorpe in 1828, has obtained the preference in the United States and is securely established in Europe. It is possible to operate at a tremendous speed, and, spinning continuously, where the "mule" spins intermittently, it produces about a third more yarn in proportion to the number of operators.

The Barber knotter, a tiny little instrument which is held in the palm of the hand, is a device used to splice broken threads, an operation that has to be done repeatedly. The operator can knot two ends of a thread by a single motion after they have been

placed in this instrument, a short cut which has reduced by a tenth the labor of spooling cotton.

In no way is the magnitude of the cotton industry better exemplified than by the place that it holds in Fall River and New Bedford. For a long time Fall River led all New England communities in its mills and is still slightly ahead of New Bedford, which is pushing it closely. In Bristol County, in which the two cities are located, there were 7,294,221 spindles in 1917. In two Massachusetts counties and one Rhode Island county there were 10,086,686 spindles in 1917, or more than a quarter of the spindles in the country.

Besides the business of planting, raising, and transporting cotton and manufacturing and selling cotton goods, there is a vast and necessary service performed by the cotton brokers, who purchase the raw material, hold it, and sell it to the factories; and then there is the vital part played by the banks and lending corporations that help out with timely loans of capital or credit in all stages of the game. In the systems of credit on

which the whole cotton industry is built there is exemplified still another phase of service rendered by modern business. The country storekeeper gives the small grower credit on his future crop; that is to say, the storekeeper supplies groceries and things needed in the household of the planter, with the understanding that he will be repaid when the cotton crop has been harvested, sold, and paid for. The storekeeper in turn is financed by the local bank; that is to say, the bank lends him money to pay for his purchases while he is waiting for the planter to pay up.

Linen fabrics, which are made of the fibers of flax, include rough sacking and sail-cloth, and delicate lawns, scrims, and cambrics. In the British Isles heavy linens, among which are canvas, tarpaulins, sackings, and carpetings, come from Dundee, Arbroath, Forfar, Kirkcaldy, Aberdeen, and Barnsley. Linens of medium weight, including duck, huckaback, and crash, are made in most of the British linen manufacturing districts. From Belfast, Dunfermline, and Perth come most of the British damasks, and from Belfast and the North of Ireland most of the fine linens.

Until the tremendous growth of the cotton industry, linen manufacture flourished in Russia, Austria, Germany, Holland, Belgium, and northern France, besides the British Isles. The greatly improved mechanical contrivances for spinning and weaving cotton struck a hard blow at linen, but, although the industry dwindled alarmingly, linen has certain qualities that no other fabric as yet can equal. Flax fibers are only slightly heavier than cotton, but twice as strong. Linen cloth is smoother than cotton; it will not soil so quickly; it does not retain moisture so long; it has a luster that makes it one of the best materials for shirts and collars; and the delicacy and strength of its thread make it the best material for fine laces. The cotton industry grew so amazingly that in 1913 the world produced 5,583,235 metric tons of cotton fiber, but flax, although outclassed, was by no means downed, as the 577,451 metric tons of flax fiber produced in that year indicate. The raw flax produced in 1913 was worth $98,-889,000; the finished linen, $456,555,000.

There are many other fabrics, too numer-

ous to tell about or even to mention, that are used in making articles of human wear — from the bark of trees, still used by savages, to the fiber of hemp, from which cloth is made that is worn in the Philippines. A very delicate fiber is obtained from the leaf of the pineapple. It is largely used in the Philippines and is called the piña.

Silk is an article of wear that is pleasing to the senses of seeing, hearing, and feeling. Let us spend a little time in studying this. The fiber is the product of an insect, the silkworm. His food is the mulberry tree, and in various parts of the world great groves of mulberry trees are maintained for the purpose of providing food for the silkworms, so that the silk can be harvested and used for making cloth.

Tradition says that the history of the silk industry began in 1700 B.C., when Hoang-Ti, the third Emperor of China, set his wife the task of examining silkworms and finding a way to use the thread of which they made their cocoons. For her diligence and success she was deified and given the title of "Goddess of Silkworms," by

which she is still known in China. And for more than two thousand years, although the Persians traded for silk and in turn sold it to the nations in the West, China kept the processes of the silk industry a secret.

In an interesting booklet on the history of silk, published by the Corticelli Silk Mills, which describes various processes of manufacturing it, certain incidents are narrated which link the story of silk with lands and people of whom the pampered modern beneficiary of their labor, as he chooses a silk tie, would never dream. Aristotle, who was the first inhabitant of Europe to learn the true origin of the silk that Alexander's victorious army brought back from Persia, described the silkworm as a "horned insect." Inhabitants of the Island of Cos, in the Ægean Sea, imported raw silk from Persia and made of it a gauze, which was called "woven wind." The Roman Emperors wore costly silken garments, but the use of silk was restricted by law to the nobility and to women; and Emperor Aurelian was said to have refused his Empress a silken robe because it was so expensive. Until the

sixth century A.D. all silk was imported by way of Persia, but when Justinian made war on Persia the supply of silk was cut off. Bribed by the Emperor, two Nestorian monks went to China and in 555 brought back a quantity of silkworm eggs in the hollow of their Pilgrim's staves, thus defying the law that forbade any one to carry silkworm eggs from China on pain of death.

The industry thereupon began to spread. From Greece and Syria it went into Spain; then into Sicily and Naples, and finally into northern Italy and France. In 1622 James I sent silkworm eggs, mulberry trees, and printed instructions to Virginia. Although that particular attempt to establish silkworms in America failed, Georgia succeeded in exporting a certain amount of silk about the middle of the eighteenth century, and various other States took up the industry. Connecticut was prominent among them for many years.

For a few years after 1830 there was an effort to establish the silk industry in the country around Florence, Massachusetts. Acres of mulberries were planted; there was

a boom, and prices advanced far beyond the real values. But in 1839 a hard winter killed most of the mulberry trees, the bubble burst, and the bottom dropped from under the prices.

In connection with the silk industry, one of the most interesting of all stories telling of the application of science to practical use is found in the "Life of Louis Pasteur," the great French scientist and savant, a book every one should read and re-read. Perhaps no one in the memory of living man has contributed so much to the welfare of the human race as did Pasteur, and his service in saving the silk industry in Europe, while by no means his most important contribution to human welfare, is typical of the methods he employed. Born in 1822, the son of a tanner, Pasteur, as a young laboratory assistant, solved a problem that had baffled scientists, in connection with crystals formed by tartaric acid. He presently got interested in the matter of fermentation. Up to the time that Pasteur made his discoveries, the scientists of the world were agreed that fermentation and

other infections were due to spontaneous generation — that they were in no way due to outside agencies. Pasteur became convinced that the introduction of germs from outside was the cause of the phenomena incident to fermentation, and he studied and followed this one line of research until he had proved his case. He was ridiculed and assailed, but stood to his guns and brought such convincing proof of the correctness of his theory that it became accepted, and is the basis on which all modern surgery and medicine is founded, and as well controls many industries, particularly those that have to do with the manufacture of wines and beverages and with the treatment of dairy products. Milk that has been specially treated to preserve it from germs is said to be "pasteurized." Pasteur also made discoveries in the use of inoculation to protect men and animals from disease.

There is no more wonderful and thrilling story than that of his experiment with sheep, in which he placed twenty-four of his inoculated sheep in an infected pasture with twenty-four that had not been rendered

immune, and guaranteed to a visiting group of scientific people and veterinarians that within so many days all of one group of sheep would be sick and all of the other well, with results even as he had foretold. In Pasteur's later days his laboratory developed the immunization that has taken much of the terror from rabies, or hydrophobia, and diphtheria.

When the silk industry of France as well as of Italy was threatened with a loss and almost with extinction, the Government called upon Pasteur. He studied the situation, learned how the disease that attacked the worms was transmitted, found the cure was to preserve only the eggs from healthy moths, and pretty soon there were laboratories established with thousands of operators to determine the condition of the moths that had laid the eggs. All eggs from diseased moths were destroyed, and the disease diminished to such a degree that it no longer menaced the industry. It is estimated that the service rendered to the world by this labor of Pasteur runs in value into many millions of dollars annually.

Since the days when the Romans bought raw silk of the Persians the industry has grown to remarkable size. Modern machinery and modern chemistry have contributed to it, as to all other textile industries, and yet to-day in the Far East methods almost as old as man still survive. From modern mills come spool silk, machine twist, sewing silk, crochet silk, knitting silk, lace silk, filo silk, Persian floss, Roman floss, rope silk, etching silk, twisted embroidery silk, buttonhole twist, dental floss, surgeons' silk, and purse twist. There is silk for insulating wires, for filaments in incandescent lamps, for tying arteries and sewing up cuts, for adhesive plasters, for surveyors' instruments, for making books and pamphlets, for winding fishing-rods, for snelling fish-hooks. All these, without touching on the tremendous range of silken fabrics!

Silk is so expensive, however, that many substitutes have been sought and some have been developed that resemble the genuine article more or less closely and use some of the same fiber. For this purpose cellulose may be prepared by any one of four proc-

esses, which are subject respectively to certain drawbacks. Three of the processes, known as the cellulose nitrate process, the cuprammonium process, and the viscose process, produce artificial silks that chemically are not dissimilar, but they all are liable to one serious defect: they lose three quarters, or more, of their strength when they are wet. The fourth process, that of cellulose acetate, produces a silk that is very much stronger when wet than any other type of artificial silk. The cellulose acetate silk, moreover, because its dyeing properties are different from those of any other fiber, opens particularly interesting possibilities. The Boston house of Arthur D. Little, Inc., has carried on many very interesting experiments along these lines. These artificial silks have their advantages and disadvantages, and present many problems interesting especially to chemists, particularly in the matter of taking dyes, and their adaptability for use. In cases where price is the most important thing, some of them can be advantageously substituted for silk.

It is hoped the service rendered to the community in the business of supplying articles of wear will be shorn of some of its evils; that the world will develop a little common sense and discontinue the manufacture and use of costly things of little durability; that manufacturers, with governmental interference if necessary, will discontinue the manufacture of shoddy goods, which means merely articles of short and inferior staple that will not stand wear; that fashions will be controlled by people of sense and taste, and not changed from year to year in the interests of milliners; that some method will be devised to prevent such atrocities as hobble skirts; and that shoes shaped so as to deform the feet will be discouraged rather than forced upon people.

I have told these stories of the growth and development of textiles so that you can get some idea of the brains and thought, capital and character that have gone into making the materials all of us wear and put on and off daily and nightly so much as a matter of habit that we hardly think of it. Our undershirts are cotton, our shirts linen

or some mixture perhaps of linen and cotton, our suits wool, or wool mixed with cotton, and our ties silk. The history of the particular piece of material that you wear, however, together with the story of the lives of those who made it, is merged and sunk beneath the dead level of the sea of many million square yards of finished product that buries beneath it the hopes, fears, heartburns, hearts'-ease, suffering, sacrifice, triumphs, and happiness of thousands upon thousands of workers.

IV

THE STORY OF STEEL

In the accounts of early days of human development we read of the Stone Age, which takes us back to a period before man had learned how to obtain metals and shape them so that they would be convenient for human use. We do not have to go back so many centuries in America to find a Stone Age here. Even now one can pick up arrowheads, spearheads, stone bowls and dishes, and other evidences of a Stone Age among the American Indians. When I was a small boy my father arranged to have my grandfather plant an elm on his lawn, and the workmen who were digging the hole brought up a perfect stone bowl, preserved to this day with great care as one of the family treasures.

Sometimes you can determine the age of man-made implements only by the objects among which they are discovered, such as the bones of animals which have become

extinct, but the period of which is known. When the mammoth, the woolly-haired rhinoceros, the hippopotamus, the musk sheep, the gigantic Irish elk, the great bear, and the cave lion were roaming about the country, our ancestors in Britain were hammering tools out of stone. By removing small flakes first from one side, then from the other, they wrought the chisels, axes, knives, and arrowheads that are unearthed now and then in the drift of past eras and are attributed by scholars to this period or that, according to the débris with which they are found.

Some savage natives of Australia even to-day make excellent arrowheads out of broken glass bottles, using as tools perhaps only a round pebble and a bit of bone. For arrowheads they also use the insulators of telegraph wires, and it is said that they have made so much trouble by stealing them that it has been found wise to leave a number of fragments of broken bottles at the foot of telegraph poles in order to provide the material that the natives would seek otherwise at the top.

After the Stone Age came the age of copper and bronze, when the implements ranged from crude, heavy forms not unlike stone axes to swords with horn handles and oval pommels. And then came the Age of Iron.

We do not know the exact dates at which one age merged into another. Indeed, the dates themselves varied according to the place and the people. It is recorded that in the fifteenth century B.C. the natives of Crete first learned from a forest fire that the ore of their island would make iron. In 1837 explorers found under the great pyramid of Gizeh a small piece of iron used in building the pyramid itself, and therefore dating from about 4000 B.C. In the exceedingly dry climate of Egypt, the process of rusting goes on very slowly, which made it possible for the iron to last so long.

Although iron was not cheap in Egypt, it was widely used, and ruins of great iron-works have been discovered on the Peninsula of Sinai. There is much evidence that iron was well known to the Assyrians, Chaldeans, and Babylonians, and the Bible conclu-

sively proves that the Hebrews knew it well. Tubal-cain was a worker in metals. Natives of the land of Canaan fought from iron chariots. Og, King of Bashan, had an iron bed. Goliath's spearhead weighed six hundred shekels of iron. In the Book of Job it is said, "He shall flee from the iron weapon, and the bow of steel shall strike him through."

The ancient Greeks knew iron, likewise. In Homer's day it was rare and precious. In the time of Alexander there were four kinds of steel, and Alexander himself took iron as plunder from the princes of India. Roman carpenters, masons, and shipwrights used iron tools, and even before the Romans came to Spain, the people there made iron. Spanish swords in the hands of Hannibal's men were turned against the Romans in battle. The Britons made iron before Cæsar invaded their country, and the remains of Viking boats show that the Vikings, too, had unearthed the secret of iron.

In Africa to-day one can see the primitive methods of working iron. Two men, squatting over a charcoal fire, force it with crude

bellows and feed it alternately lumps of charcoal and of iron ore, and thus extract the metal. We know, also, a good deal about the ancient iron industry in various countries. In Roman times in Britain and Belgium iron was made in conical holes in the ground, which were made in such a way that the wind would blow into them and keep up a hot fire without the bellows that are used to force air with its burden of oxygen into the fire. In southeastern Asia natives forced the draught by pumping air through hollow bamboo with loose pistons. In Egypt a bellows consisting of two goat-skins, one under each foot, attached to a single pipe, was used. And, finally, in the Mediterranean countries the Catalan forge, which was similar to an ordinary blacksmith's forge, was invented.

The Romans who carried on the iron industry in Britain left so much iron in the clinkers, which they could not extract, that for several centuries the tailings were smelted with good profit. It is estimated that to make iron to-day by the old Roman methods would cost one thousand dollars a

ton. We make steel now for five dollars a ton.

Remarkable stories are told of the quality of the old Bilbao, Damascus, and Toledo blades, and every one who reads mediæval romances is familiar with the reputation of Milan steel for turning off or shattering well-aimed arrows. Smiths and armorers then were the aristocrats among craftsmen. Knights and nobles whose lives depended on the temper of their weapons were bound to honor and reward handsomely the men who had mastered the art of making them. But it is probable that the skill of the mediæval smiths has been exaggerated. If an occasional blade would slice through iron bars or sever silken scarves floating in the air, there were bound to be many inferior blades, for the methods then used were anything but precise and the products were of uneven quality. We are making better steel to-day than ever was made before, and we certainly are making steel of much more even quality as well as in vastly greater quantities.

And yet the iron and steel workers of the

Middle Ages, who hammered out swords and sickles and plate armor and ploughshares, command our interest. Think of the lonely hamlets scattered through the forests of England, each with the great house of the lord of the manor, the huddled huts of the villagers, the tilled fields, the common pasture, and the smithy where metal-work of all kinds was wrought of white-hot iron. Perhaps it was a community of Saxons, such as that of Cedric of Rotherwood; perhaps a Norman knight held court of a sort in a castle on the hill. Now the smith was forging tools for husbandry; now he was repairing armor for a great tourney; now news of war came down the lonely forest paths, old weapons were overhauled, and off went master and men to fight. In battle and siege, invasion and crusade, the battle-axe of the noble and the halberd of the guard depended, one and all, upon the skill of the iron-worker. In hamlet and camp, in town and castle, the smith was a man of mark and his forge was a center of interest that has no parallel in our towns and cities of to-day.

The first use of iron was, of course, in very

crude shape. Iron is naturally soft. That means not that it feels soft to the touch — nobody wants to stuff a pillow with it — but comparatively soft. It means that it will not take an edge that can be used for cutting and will be easily dented if struck by a bit of really hard substance, such as steel or flint. Little by little, however, people have learned, and are still learning, new devices for giving iron and steel different properties, and with this knowledge have come many new uses for iron and its various forms that would make a list far too large for any book smaller than an encyclopædia.

Iron was first shaped by beating small balls of the metal into various forms with a hammer. Better and heavier hammers enabled the smiths to work more rapidly, and thus on an increasing scale the work was done until the rolling process was invented about 1783.

The invention of the steam hammer about 1835 was a long step forward in forging iron. So nicely is the machinery that controls these hammers adjusted that one of them weighing several tons will break an egg with-

out cracking the egg cup that holds it, flatten a piece of iron, or break the crystal of a watch without in any other way injuring the watch itself.

Iron containing carbon — that is, steel — can be hardened by cooling it suddenly, when cherry-red, in oil or water. When the metal has been thus hardened, it is possible to return it to its former softness by heating it to the same cherry-red and cooling it slowly. Of the great care that must be taken in cooling the hot metal the uninitiated have little idea. Each piece presents its peculiar problem. Of course the part that is thinnest cools first if plunged into water, and if one part cools before another, a crack or a warp is inevitable. To realize what an art it is to handle successfully hot steel, one need only read such a book as "The Management of Steel," by George Ede, a little old volume which sets down carefully and deliberately the knowledge gained by many years of handling steel as it was made in the first half of the nineteenth century. How to forge cast steel in all the various shapes and harden it and temper it by repeated heating and

dipping were problems that required study and careful workmanship.

Fundamentally steel is an alloy of iron with carbon. A certain proportion of carbon gives it the intense hardness that is desired, and the method of distinguishing between wrought iron and steel used to be to dip the metal in water when it was cherry-red. If it were steel, this hardened it and made it brittle.

But there are new alloys now which give iron the hardness of steel and at the same time various other qualities. To dip hot manganese steel into water makes it less brittle and a little softer; and it is impossible to soften it by annealing; that is, by heating it and cooling it slowly. It is the exact opposite of the old carbon steel. The same is true of a steel made with an alloy of nickel. Iron and carbon steel and magnetic oxide of iron are strongly magnetic, but manganese steel is so free from magnetic qualities that it can be used instead of copper or brass where a non-magnetic material is required. Thus the alloy steels — manganese, nickel, chrome, tungsten, silicon, vanadium, tila-

nium, and so forth — have their particular and valuable qualities.

To illustrate this still further, eleven per cent to fourteen per cent manganese steel, which contains one per cent carbon, is so hard that it cannot be cut or drilled by tools. Besides serving for use where non-magnetic metal is desired, it is used for steel rails round sharp curves, rolls and crusher parts, steam and dredge shovels, grab-buckets, sand-pumps, gears, and pinions. Because it resists drills and is too tough and strong to be broken by ordinary methods, it is used for making safes. It is said that no manganese steel safe has ever been drilled or forcibly entered.

A ton of molten cast iron contains approximately fifteen pounds of manganese, twenty-five pounds of silicon, and seventy pounds of carbon, all of which is excellent fuel. Now if air is blown through or upon molten iron, the oxygen of the air burns out the carbon, silicon, and manganese, and thus raises molten iron from a temperature of perhaps 2300° F. to a temperature of about 3000° F. This is the basis of the Bessemer

process, which there is much reason to believe really was invented by William Kelly, of Eddyville, Kentucky. From mixers, which hold the metal from the blast furnaces, the molten iron is poured into a big, egg-shaped converter. From the converter, which swings into an upright position as the ladle that brings the metal from the mixer is withdrawn, come first smoke and sparks, then flame. First the silicon and manganese are burned out, then the carbon, which takes fire when the others are about half burned, then the flames die down, and virtually pure iron is left in the converter. The iron itself is liable to burn also if care is not taken. Of course finished steel must contain carbon, and the carbon in the iron has been burned. To remedy this, enough carbon must be put back into the iron to give it the desired composition, and enough manganese to rid the iron of injurious gases and oxides, and to prevent "red-shortness." When the flames die down, a small ladle brings to the converter exactly the quantity of other substances, such as carbon and manganese, that are necessary for the par-

ticular steel that is wanted, and the steel and slag from the converter are poured into another ladle below and thence through a nozzle in the bottom into ingot moulds.

One wishes that some necromancer could call from the shrouds of the long dead the ghost of the man who first conceived the idea that iron might be made into useful shapes, and let him see the development of his original crude idea in this, the twentieth century.

How did it happen that he made the discovery? Perhaps it was by chance. Perhaps some stone used for supporting his clay vessels used for cooking chanced to be iron ore, and the iron got melted by the heat and ran out into the ashes and was picked up, possibly having cooled in some shape that suggested a use as a hammer or mace-head. One can easily imagine dull people seeing this happen over and over again and not realizing the possibilities which it held till our ingenious man happens along and finds where the particular rock came from and what it looked like. He then follows it up and finds more and learns how to tell it

when he sees it. Then he makes a great fire and catches the liquid metal, and instead of having it run into the ashes and cool in any chance shape, he pours it into a mould, and thus the foundry has come into being. The foundry, be it known, is a place where moulds are made of different shapes and metals are melted and poured into the moulds and allowed to cool.

An Englishman named Jeremy Floris invented sand moulds for castings, which displaced the much inferior method, formerly prevalent, of moulding in clay. In moulds for "chilled castings" pieces of iron called "chills" are embedded in such a way that the melted iron which touches them becomes, when cool, white and extremely hard. By changing the size and arrangement of the "chills" the quality of the finished casting, and of any part of it, can be controlled. For some steel castings moulds of "green" — undried or unbaked — sand are used; for others, moulds of baked sand, which give a finer finish and surer results.

From the standpoint of metallography, cast irons are simply steels in which there is

what we might call an impurity or an adulterant, "graphite crystals," a prominent metallurgist puts it. If iron is poured into a mould the surfaces of which are made of iron, the molten metal cools very rapidly indeed, and this, not giving the carbon of the alloy time to change into the graphitic form, makes a white and hard but brittle cast iron. By the use of "chills" in the moulds, however, the quality of the iron is so controlled that castings are made with a hard white surface and a gray interior, which is less brittle and less liable to break under a shock. Car wheels are made in that way, for example, with a white iron surface to run on the rail and a softer, gray iron core to back it up and keep it from breaking.

There are many degrees of hardness and brittleness in cast iron, and steel castings provide in turn a new set of problems. To describe in detail the range of purposes for which castings are made would take a whole book in itself. In a sense it is farther from the first mould to the foundry that makes modern steel castings than from the earth to the moon and back again.

Would not the eyes of that first foundry-man start wide open in amazement could he see the vast forgings turned out by our great mills; could he see a ship like the Olympic, with plates in her hull thirty-six feet long and weighing four and a half tons, with a single steel beam ninety-two feet long, and with three propellers, two weighing thirty-eight tons apiece and one weighing twenty-two tons! The rivets alone that hold together the steel plates of such a ship weigh two hundred and seventy tons.

Think of the number of tons of metal used in protecting a first-class battleship. In the story of armor plate there is the realization of such battles as the ancients thought were fought only by the gods. Where in all mythology is there anything to compare with Jutland? Legendary struggles once regarded as titanic dwindle to child's play if compared with a battle fought over league upon league of open sea — a battle in which thousands of pounds of metal and explosive were driven for miles from gun to ship with terrific force, in which steel structures of stupendous power maneuvered

at high speed and, without visible sign, maintained perfect communication with one another over vast spaces of open water.

The first armor plate that actually was tested under gunfire consisted of two layers of iron bars one and a quarter inches square, vertical and horizontal, laid on a wall of granite seven feet thick. It went to pieces under bombardment by a twenty-four-pound gun. This happened at Woolwich in 1827. Until 1855 experiments with armor plates on floating batteries were carried on in America, England, and France, and in 1855 the first ship to carry armor, the French Gloire, was equipped with plates of rolled iron four and three quarters inches thick. It is interesting to note that the same firm that made the iron plates for the Gloire, Messrs. Schneider, in 1876 made the first steel armor plates.

The plates of wrought iron served their purpose perfectly against cast-iron projectiles until, in 1863, an inventor learned to harden the points by pouring them into cast-iron moulds, or chills, and to back them with softer metal by pouring the

cylindrical bodies into sand. To meet this invention, the shipbuilders increased the thickness of plate until, from the four-and-a-half-inch plates of the British Warrior, the armor grew in 1877 to the twenty-four-inch plates of the Inflexible.

Steel at first was too brittle to make good armor plate, but one new development followed another until in 1891 Harvey's method of hardening the face of steel plates was adopted in the United States. Krupp, three years later, advanced a step farther and toughened also the back of the plates by a special and technical process.

The armor plates of to-day, which are compound and carbonized, combine the best characteristics of both the hard, rigid, and brittle plates and the tough, yielding, homogeneous ones. The twelve-inch gun of 1864 had a projectile of 614 pounds, a muzzle energy of 7195 foot-tons, and could penetrate eight inches of wrought-iron armor at 6000 yards. The twelve-inch gun of to-day, with a projectile weighing 850 pounds and a muzzle energy of 53,045 foot-tons, can penetrate a nine-inch plate of Krupp armor,

the equivalent of a seventeen-and-a-half-inch plate of wrought-iron armor, at more than thirteen miles! In other words, it hits more than twice as hard at four times the distance. Think what an advance in power this is over the missiles sent forth by the cave man with his bow or sling! Compare their weapons with those with which the British experimented during the World War—eighteen-inch guns weighing 149 tons that, with a charge of 630 pounds of cordite powder, hurled a shell weighing a ton and a half and at a great range pierced sixteen-inch armor! They have estimated that a twenty-inch shell weighing some five thousand pounds will pierce sixty inches of armor at the muzzle and thirty inches at a range of ten miles. Although such figures are interesting for comparisons, in real importance to mankind the uses of steel in other fields of activity quite overshadow its uses for warships and guns.

There is one disadvantage attached to iron. It rusts readily, and when exposed to moisture disintegrates rapidly. A variety of processes have been discovered to obviate

this. There are special paints which help to prevent rust; and there are various patented preparations applied like paint, which contain a good deal of oil and which are more or less dependable. Paraffin oil alone is often used for this purpose. Steel sometimes is dipped into a tub containing a heated solution of unslaked lime, which gives it a good surface for stamping or drawing. Processes for covering the surface with rust-proof metal, known as plating and galvanizing, are much used, and there also are certain "rustless" steels which are made by the use of alloys, usually by secret methods.

The history of the steel business in America from 1644, when "The Company of Undertakers of Iron Works" was organized in England, until the United States Steel Corporation was formed, vies, as far as sheer romance is concerned, with any one undertaking in any similar period in human history. From a little business in Lynn, Boston, Braintree, and Hammersworth, it grew moderately and spread slowly until William Kelly discovered the process that bears the name of another, Sir Henry

Bessemer, which Mushet perfected. From that time on it grew with a speed and volume that staggers the imagination.

A man named Philo M. Everett, of Jackson, Michigan, with four other white men and two Indian guides, went into the wilderness now known as the Marquette, Gogebic, and Menominee Ranges and discovered mountains of iron ore, from which since that time seven hundred million dollars' worth has been taken out.

Charlemagne Tower, a wealthy coal-land and railroad man, was persuaded to build a railroad from Lake Superior to the Vermilion Range. When he had spent three and a half million dollars and had only a million left, George C. Stone, who had got him to venture his money in the project, told him that they must have half a million more, if the mines were to be started. Facing the loss of all his property, he finally "went the limit." The railroad and the mines started and succeeded, and Charlemagne Tower sold the property for eight million dollars — twice what he had invested. His service to the community, measured in increased

facilities and cheapness of products of iron and steel, is doubtless many times this figure.

The most prolific source of iron in America is the wonderful Mesaba Range in Minnesota which is a vast mountain of loose ore. The practice which has been adopted in mining this is to strip off the surface soil, sometimes as much as sixty or seventy feet, until the ore-bearing earth is exposed. This is then dug out by steam shovels; trains of waiting cars are placed on tracks beside these shovels and filled with ore at a low cost per ton. The haul down to Lake Superior is a gravity haul almost all the way. That means that the ore-laden trains coast downhill and the ore is dumped into pockets from which it slides by means of gravity into the holds of the steamers.

Some idea of the size of this business can be gained from the fact that, in 1916, 33,000,000 tons of ore were hauled from the Mesaba Range alone, and the total Lake Superior iron-ore production for that year was 64,000,000 tons. The pig-iron production in the United States for that year was 39,000,000 tons.

Where in, or out of, the Arabian Nights is there a story to equal the true story of Andrew Carnegie, son of a poor Scotch weaver, who came to America in a little sailing ship in the forties and died in 1919? His share of the benefits he conferred on the community in the production of steel — or shall we say the price the world paid him for his services? — came to many millions of dollars, most of which he paid back in the form of libraries, gifts to institutions, and the creation of several foundations and funds to be spent for the betterment of the living conditions of his fellow-men.

Turn where you will, go where you will, to-day steel is always present, but it is not easy to realize how much steel has contributed to increasing the effectiveness of man's work. The part it has played, and still is playing, almost defies the imagination. Each steam shovel or steam hammer does the work of a small army. By moving levers a man whose greatest effort will not budge a weight of more than a few hundred pounds can put into motion and control absolutely mechanisms that handle with ease tons

upon tons of stone or metal. There are cranes that handle masses of molten iron weighing as much as one hundred and fifty tons. There are hydraulic presses whose power is equivalent to seven thousand tons or more. In a power station of what was the Manhattan Street Railway Company there is a steam turbine of eight units, which produces *one hundred thousand horse-power*. Skyscrapers, steamships, bridges — they all bear witness to the power that the mastery of steel has given to man.

So greatly has our ability to manufacture and transport goods increased, and so much richer than ever before is the world in things made by man, that every laborer to-day enjoys luxuries that a few hundred years ago were beyond the dreams of any but the wealthiest and most powerful. All this steel has helped to do for us.

In 1880 we produced 1,247,335 tons of steel; in 1913, the year before the war affected the normal growth of the industry, we produced 23,513,030 tons. To judge of the magnitude to which the industry has grown, consider these figures of the United

States Steel Corporation: it owns territory equivalent to the area of the States of Massachusetts, Vermont, and Rhode Island; it employs 180,000 men and provides the livelihood of more than a million people; in wages it has paid out vast amounts; it owns enough railroad track to reach from New York to Galveston; it operates thirty thousand cars and seven hundred locomotives; it owns nineteen ports and a great fleet of vessels; and it can make anything from a carpet tack to an Eiffel Tower!

And now we come to the part that iron and steel play in our daily lives. It is almost impossible for any of us to realize the magnitude and extent of it. Steel elevators, propelled by steel machinery, move us up and down buildings. We lie on an iron bed, supported by steel springs, often sheltered by a steel roof; the floor beneath us is supported by steel beams. The frames of our biggest buildings are steel. Water is brought to us in iron pipes, controlled by iron faucets. We are carried about in cars with iron bodies, whether motor, tram, or steam railroad, and pro-

pelled or drawn by machinery of which steel is the most important component part. Our houses are heated by iron furnaces, our food is cooked over iron ranges and is cut with steel knives. We have iron fences to keep intruders out and our live stock in. We put up iron lightning rods to draw off the menace of the elements. We go to sea in iron ships that float us safely about, propelled by steel machinery. Our sailing vessels have iron masts, steel rigging, and even steel ropes. Most of the machinery which is used for saving the labor of man is of steel. We send messages by electricity over iron wires, and delight our ears with music caused by the vibration of steel wires. Steel lends itself to domestic uses such as sewing machines, needles, and pins. The implements that almost every man uses in his trade are made of steel; the carpenter, the smith, the plumber, and the engraver — all use instruments of this material. And these are only a few sample cases that come readily to mind. Any one can think of uses I have not mentioned.

Just suppose some planet with unheard-of

magnetic force came swirling close by and drew off all the iron and steel in the world! With what a marvelous collection of articles of human fabrication would space be filled! Here a can buoy, there a child's supply of toy cars. Yonder a one-hundred-ton locomotive. The forceps would fly from the surgeon's hand, the drill from the dentist's, the razor from the barber's—and we hope it would not take off an ear as it went—the scissors from the dressmaker's and the ladle from the cook's. Our stone buildings would crumble and collapse, our wooden houses would fall apart and topple down. Our means of transportation and communication, our labor-saving devices, implements of the husbandman, artisan, and housewife — all would be badly crippled. And those of us who survived the starvation that would undoubtedly ensue would find ourselves back in a condition bordering on the state of the primitive village. And so we should remain until some substitute could be devised and we had time to provide for its introduction into our lives.

Mighty is steel!

V

THE STORY OF TRANSPORTATION

In the early days of human development it is probable that only those comforts came to each community which were produced in its immediate vicinity. Each tribe was usually at war with its neighbors and could expect only an exchange of weapons or blows; there were very meager physical means of communication even if the desire for communication had been strong. Commerce requires roads and vehicles, ships and skill in matters of trade, as well as reasonable security and protection from violence.

So let us return to our concept of a village, such as exists to-day among the few savages who live in the hills of the Philippines, where each community is absolutely self-contained. There the men until very recently occupied advantageous positions on the hilltops with their spears and shields and head axes, while the women and children toiled for the meager daily pittance of

rice and sweet potatoes. We have already indicated the nature of the beginnings of transportation. The first land transportation was, of course, on the backs of the people — the savages in the hills of the Philippine Islands still serve their fellows as beasts of burden. And then came our ingenious man and devised a plan of making some domestic animal serve the purpose. The horse, the donkey, the mule, the camel, the elephant, the llama, the ostrich, the cow, the ox, the bull, the buffalo, the dog, the reindeer, the goat, and others — all came in turn and have had to obey the behests of man and carry his wares from one place to another. The first freight was undoubtedly packed on the back of the beast of burden, for wheeled vehicles and even sledges, since they presupposed the existence of the cleared path, must have been much later inventions.

The first loads to be drawn were undoubtedly drawn on sledges, perhaps similar to those we have recently legislated out of existence in the Philippines. The easiest one to make consists of two poles fastened to-

gether so that the front ends form shafts while the after ends drag on the ground, the freight being strapped to the poles far enough back to clear the heels of the animal that draws them, and far enough forward to clear the ground. This primitive device could carry only a small load and the dragging ends of the poles tore up the surface of whatever road they passed over, much as a blunt plough might do, and that is why we had them stopped in the Philippines.

The wheels that prevailed in the Philippines when I first went there were solid disks of hard wood, fixed to the axle, and having narrow iron tires perhaps an inch or an inch and a half wide. These narrow rims in time would cut through the best surfaced road, and the effect of having the wheels fixed to the axle was that when the cart turned round the wheels could not make the appropriate turn of one going back and the other forward. The resultant movement of the narrow tires was such that one of the wheels could pry a cobblestone right out of a paved road. We had to pass laws prohibiting the use of these vehicles also, and the antiquated

devices gave way to wooden carts with wheels and tires three or four inches wide, which served to smooth the surface of a road rather than dig it up, and turned, as good wheels should, on the axles.

Just think how long it took to find out that a pair of rails will greatly increase the efficiency of locomotion and enormously increase the hauling power of our locomotive force, whether man, animal, or machine!

It would be difficult to say when the first rails were laid, but we know that as long ago as 1676 railed roads for carrying coal from the mines to the banks of the Tyne were used in Northumberland near Newcastle. The rails were made of timbers laid, in the words of an earlier writer, "exactly straight and parallel," and carts were built to run on rollers that fitted the rails, so that a horse could draw a much heavier load thus than over the rough highways of the time. The timber rails wore out rapidly, but a hundred years later cast-iron rails were used. In 1800 some one suggested that railroads could be used to carry merchandise, and then came

the startling suggestion that they could be used to carry passengers.

When Professor John Anderson, of Glasgow, in 1803, wrote a plea for railways, which enumerated with a pen that to-day seems genuinely prophetic the various advantages that would follow the wider use of railways, such as reducing the cost of necessaries, widening the circles of intercourse, bringing the country nearer the town, planting mines and manufactories in neighborhoods once considered as isolated by distance, and literally changing the course of history in whole countries, he fell far short of what actually has come to pass as a result of the very thing he proposed, although his mind advanced an amazing distance beyond his own time.

We are accustomed to regard George Stephenson as the inventor of the locomotive, but there were steam carriages long before Stephenson. In the seventeenth century Isaac Newton designed a locomotive, or road engine, consisting of a carriage with a circular boiler in the center of it, and, although it was too primitive to be worth

much, it suggested the general idea of the later locomotives. The first practical road carriage propelled by steam was built under the direction of a French military engineer named Cugnot in 1763, another in 1769, and still another in 1770. The third of Cugnot's carriages, having a broad front wheel, which supported both engine and boiler and thus pulled the rest of the carriage after it, resembled the road-rollers that are familiar sights on our streets to-day. It was ordered by the French Government and was to have transported artillery, but it was never actually put into use and it is now preserved in the Conservatoire des Arts et Métiers in Paris. James Watt also patented a locomotive, but he was working on stationary engines in partnership with Matthew Boulton at Soho, and, dropping the matter himself, in company with his partner he discouraged his employees from pursuing the study of steam-propelled vehicles and thus was influential in destroying one William Murdock's prospects of fame and fortune.

Murdock was a gifted mechanician, best known, perhaps, as the inventor of gas-

lighting, who was engaged in erecting engines for Watt and Boulton, Mr. Ernest Protheroe says in his very interesting book, "The Railways of the World," when he bent himself to the task of constructing a self-propelling carriage. He completed a model, which can be seen to-day in the Birmingham Art Gallery, and decided one night to test it on a well-rolled path leading to Redruth Church. "No sooner had he got up steam than the little locomotive started off at something like seven miles an hour, with Murdock in hot pursuit. The inventor was filled with pleasurable excitement at his success until shouts of terror from ahead smote his ear. He found that the cries emanated from the parson and his wife returning home in the dark to find themselves suddenly confronted by some mysterious object, snorting and zigzagging along the road in front of them. Their fears were appeased when they learned that Murdock was in charge of it, and the worthy couple agreed to keep his secret."

When Murdock was on his way to London with his model to take out a patent, he

most unhappily met his employer, Boulton, who dissuaded him from the trip and wrote to Watt the following account of the incident:

"He hath unpacked his carriage and made it travel a mile or two in River's great room, making it carry the fire-shovel, poker, and tongs. I think it fortunate that I met him, as I am persuaded that I can cure him of the disorder, or turn the evil to good. At least, I shall prevent a mischief that would have been the consequence of his journey to London."

Poor Murdock! Although his model was only a toy, it might have led to great things but for that "fortunate" meeting.

In 1801 Richard Trevithick and Andrew Vivian carried passengers on the road in a steam vehicle, and proceeded to build a steam road-carriage that ran from Camborne to Plymouth — a hundred miles — and afterwards ran in the streets of London to the amazement of the metropolis.

Meanwhile, in 1789, William Jessop had built what may be regarded as the first real rail line, which consisted of cast-iron three-

foot rails spiked down to cross-sleepers and was notable for being sufficiently elevated to permit the use of flanged wheels instead of following the hitherto prevailing custom of having the flanges built as a part of the rails themselves.

If any one had then asserted that it was a great day in the history of the world when a boy named George Stephenson, the son of a poor workman, who had begun to earn his living at eight years of age by herding cows for twopence a day, was appointed "picker" at the Wylam Colliery, which means that he was to pick the bits of stone and other impurities out of the coal, he would have been laughed out of court. But a great day it was, and perhaps it was an even greater day when Stephenson was promoted to help his father fire the engine, and when at the age of seventeen he himself became head engine man.

When in 1814 Stephenson built Blucher, his first locomotive, he had come through years of desperate struggle against poverty; he was intimately acquainted with the problems of the tram-lines that were used at the

Northern collieries, and he was confident that he could improve on Puffing Billy, as the second Hedley and Hackworth engine was known, which was built in 1813 and was more successful than any of its predecessors. Blucher at first was unsatisfactory, but, refusing to fail, Stephenson turned the waste steam into the smokestack, doubled the power of the engine, turned defeat into victory, and thus began the career that has made his name and his story familiar to every schoolboy.

Although Stephenson did not invent the locomotive, his inventive genius enabled him so to improve it that it became possible to apply it to the wider uses that his foresight and imagination conceived. It is as the father of the modern railroad, with its vast and complicated organizations, both mechanical and financial, that Stephenson is famous.

In 1815 Stephenson built a new locomotive, which was used with much success at Killingworth; in 1820 John Birkenshaw showed the world how to roll longer rails at a lower price; and in 1821, because the difficul-

ties of navigating the Tees hindered the Northern coal trade, Parliament consented that a railroad should be built between Stockton and Darlington. According to the bill, as passed by Parliament, vehicles could be drawn on the new road by "men, horses, or otherwise," and Stephenson, on the strength of his earlier successes, convinced Mr. Edward Pease, one of the promoters, that steam was a desirable interpretation of "otherwise."

It is hard to-day to realize the difficulties that George Stephenson met and overcame. Some of the directors of the new road were openly hostile to his project; he had to form a company to build his locomotive; he had to overcome the desire of the directors to use cast-iron rails and persuade them to use malleable-iron rails instead, which cost four times as much (he himself would have got £5000 more by using cast-iron rails because he had a half-share in the patent); and, in spite of all his work and confidence, the directors remained so skeptical that they bought a large number of horses to help the engine on the opening day of the new road.

But on September 25, 1825, the Stockton and Darlington Railway was opened, the new locomotive disappointed the skeptics by not blowing up, and amid tremendous excitement Stephenson won all the honors of the day.

First came his engine, Locomotion, which he himself drove. It drew six trucks loaded with coal and merchandise; Stephenson's first railway passenger coach, called the Experiment, which carried the directors and their friends; six wagons loaded with strangers; and enough more wagons to round out forty. The train weighed ninety tons. Locomotion set out at ten miles an hour and reached the magnificent speed of fifteen miles an hour during parts of its journey.

The surprising success of this line led promoters to renew their proposal to build a road between Manchester and Liverpool, and Stephenson undertook to survey the route. But "landowners feared that the lines would disfigure the countryside," says Protheroe; "farmers were afraid that their live stock would be in a constant state of fright, and that no hay or corn-crib would be safe from fire. 'Another large section of

the public opposed to railways consisted of persons engaged in the coaching trade and in occupations directly or indirectly connected with it. It was obvious that drivers and guards, grooms, coach-builders, and many others would find their occupation gone if railways were a success, and that the inn-keepers on the coaching-roads would lose business." Stephenson was angrily warned off many estates, and in some cases the employees of specially rabid opponents damaged valuable surveying instruments, and threatened the engineer himself with personal violence.

Ultimately, in defiance of those who regarded his statements as absurdities, and in spite of promoters who had lost confidence in him, Stephenson won. When the bill was passed after a new survey by a new engineer, and when the new engineer gave up the job, Stephenson took it once more. He built the road and he built a locomotive that in competition made twenty-nine and a half miles an hour when it was running without cars, and twenty-eight miles an hour when drawing a car with thirty-six passengers.

From that day to this we have advanced steadily in our railroad service, both in our results and in the complicated means by which we obtain them. We have journeyed a long way from that simple first passenger coach, the Experiment, which in its pictures reminds us for all the world of a box-car. There are between 9000 and 10,000 separate parts in a modern locomotive and more than 7500 separate parts in a modern tender.

Since the day when Stephenson was derided as a madman — because he said that his engine could travel twelve miles an hour as easily as four — there have been numerous long-distance runs of passenger trains, varying in lengths from 58 miles to 1025 miles at speeds varying from 76.5 miles an hour to 58.7 miles an hour, and a passenger train of the Philadelphia and Reading line has run from Egg Harbor to Brigantine Junction — 4.8 miles — at a rate of 115.2 miles an hour. In 1903 the Safety-Pin Express won a unique place in the annals of railroading, although it broke no speed records, by running from St. Regis Lake in the Adirondacks to New York City — 400 miles

— in ten hours, to carry a seven-months-old baby, who had swallowed a safety-pin, to a doctor at the Roosevelt Hospital. (The pin was removed without permanent injury to the small patient.)

A freight engine that the Delaware and Hudson Railroad bought from the American Locomotive Company in 1910, which was said to be the most powerful locomotive ever used, could haul on level tracks 10,190 short tons. On a grade of 1 in 200, it could haul 6255 tons; on a grade of 1 in 25, it could haul 915 tons. For experimental purposes a giant locomotive of the 3000 class Mallet oil-fired compound (2–10–10–2) has hauled a train of 4340 tons a distance of 111.5 miles in 140 minutes. Such locomotives are built to haul freight on grades of 90 feet to a mile. Many of them haul, on an average, loads of 1900 tons at speeds of as much as 15 miles an hour.

One can hardly credit even the genius of Stephenson with an imagination that could conceive of a single engineer with his hand on a throttle that could uncork the thousands of horse-power necessary to move a train of 120 freight cars, making in all a load

of 6300 tons, 127 miles in 9 hours and 36 minutes, or an average of better than 12 miles an hour. Yet this run was made by the Pennsylvania Railroad between Altoona and Enola Yard, and the train was so long — nearly a mile — that it required telephone connection between the engineer and the brakeman on the rear car.

One can easily figure the increase in efficiency that steam gives us when we apply it to human conveniences. A man can carry, let us say, a load of fifty pounds a distance of twenty miles in one day. The engineer, with the assistance of fireman and train hands, carries 6300 tons a distance of 127 miles in a little more than nine hours. Bring all this down to the unit of ton-miles. The primitive man carried fifty pounds a distance of twenty miles, or the equivalent of one thousand pounds one mile, that is, one half ton-mile a day. The modern man, assuming that there were ten trainmen employed on this train, among whom to divide the 800,100 ton-miles that the train carries in a day, achieves 80,010 ton-miles, or 160,020 times as much as the primitive man.

This, of course, is really an exaggeration, for we are comparing an average man's load with a most unusual railroad achievement, and, moreover, switch tenders, telegraph operators, business men, clerks, executives, and mechanics of every description have a part in every train that moves, but the figures are sufficiently large to provide an ample margin for the assistance of others and still show a marvelous increase in man's efficiency.

In 1918, in the United States and her territories there were 253,529 miles of railroad, 66,334 locomotives, 2,411,973 freight cars, and 56,505 passenger cars. In 1919 they carried 1,169,307,000 passengers and 1,998,917,000 tons of freight.

Street railways have built up our cities tremendously by enabling the workingman to live miles from his work and yet go back and forth from his home economically and quickly. Although under the conditions that prevail to-day the heavy cost of maintenance has hit hard at our trolley lines, the extensive suburbs of our larger cities are monuments to their great usefulness. In

1917, according to the latest United States Census data on the subject, there were 1307 electric railway companies in the United States. They operated 32,547.58 miles of line or 44,835.37 miles of single track. Their road equipment cost $5,136,441,599. They had 294,826 employees on their payrolls and spent $769,825,092 for operating expenses. They carried 11,304,660,462 revenue passengers.

Equally interesting and fascinating, and even more picturesque, is the growth of water transportation. Probably rafts were the first contrivances devised by man's ingenuity for floating first men and then goods, perhaps in the effort to cross rivers. Later probably came the idea of floating goods down rivers on rafts by poling them along. The substitution of paddles for poles is an easy transition, and the dugout to this day persists among many peoples who live in forest regions.

When did the idea of sails first come? It is natural to think of using some mat or bit of cloth to help a boat down the wind. But what genius first conceived the idea that

sails could be trimmed in such a way as to propel a boat against the wind?

Ask any group of intelligent people seated in a room whether it is possible to install a windmill in a boat and connect it to a propeller so that the boat will be driven against the wind, and the majority of your friends will tell you positively it cannot be done. Yet it can be done and has been done. There is no difference in principle between the windmill propelling a boat against the wind and the sails doing it. The force of the wind is utilized to drive the sail-boat ahead and modern science has learned how to make the boat move very nearly toward the place the wind comes from. The use of a windmill in a boat is of no practical value, however. It is only interesting as a matter of theory.

This is no place for a history of sailing vessels. Even to-day there are many kinds, many designs, and the great advances made in America in the matter of design and rig are finding their way very slowly over the world. And still one finds junks in China, luggers in Northern Europe, proas and vintas with outriggers in Moroland, lateen sails

and baggy sails, and everything but the latest and most modern boat. The habits of centuries are slow to change.

Personally I am a very strong advocate of the America's Cup races. I think they have given the stimulus which has proved to be the leaven that leavens the whole lump. It matters not if the boat developed is in itself unserviceable. The principles of design, rig, and management are serviceable and will influence the commercial development of sailing vessels till the world ends.

It is interesting to trace the development of model and rig. Consider, for example, the resemblance between the junks that we know to-day and the galleons or caravels of yesterday; consider, too, the lofty poops of the vessels of Henry and of Elizabeth, which gradually grew lower and lower in succeeding years until such ships as the George of Salem (1815) show a deck as straight from end to end as the edge of a ruler. The sail plans alone of different eras make an intensely interesting study. Down to the seventeenth century European ships showed by lateen sails a kinship with the feluccas of

Mohammedan countries. The great single topsails of the eighteenth and early nineteenth century ships, so hard to handle when frozen stiff or bellied out by a gale of wind, gave way to the divided topsails that are characteristic of the square-riggers of to-day. The fore-and-aft rig, which requires fewer men and is easier to handle for coastwise service, has largely displaced the square-rigged barks and brigs of other years. The long voyages before the trade winds, for which square-riggers are best fitted, are most often made now by steamships.

Fascinating as sailing ships are, the sails had to give way to steam. Every one knows the story of Fulton's early struggle against ridicule and incredulity and discouragements of every kind. Before Fulton's experiments John Fitch, of Pennsylvania, had built two workable steamboats and organized a company to run them, but he was so far ahead of his time that the company failed to pay dividends, and eventually he killed himself. Various others had experimented with steamboats with more or less success, but it remained for

Fulton to silence conclusively the jeers of those who gathered to ridicule his experiment, when, having imported a Watt engine, having with greatest difficulty raised the money for the venture, and having had built a boat so narrow that sailors called it "Fulton's Folly," he finally sailed up the Hudson, as one writer puts it, with "a cloud of fire moving along between heaven and earth like that which had guided the Children of Israel in the desert." Strange stories are told of the abject terror of the crews of the vessels that the Clermont passed during that wonderful first voyage.

Although steamships have generally replaced sailing ships, some records of the old clipper ships are by no means to be sneered at. These vessels, first developed at Baltimore, Maryland, and later made in large numbers in the building yards of Essex and Salem, represent the pinnacle of commercial sail-boat construction. They were sturdy and beautiful boats, built for long voyages, and they were marvels of speed. This result was accomplished by narrow lines and an enormous spread of canvas. Many achieved a

speed in excess of nineteen knots an hour. The fastest average run for twenty-four hours was eighteen and a half knots. Although the modern liners are faster, a glance at the following records convinces one that the accomplishments of the clipper ships were remarkable. The Flying Cloud made the voyage from New York to San Francisco *round the Horn* in eighty-nine days; the Water Witch made the run from Canton to New York in seventy-seven days; and Samuel Samuels drove the Dreadnought from Sandy Hook to Queenstown, a distance of twenty-seven hundred and sixty miles, in nine days and seventeen hours. To be sure, the Mauretania made the run from Queenstown to New York in four days, ten hours, and forty-one minutes, but the master of that famous old packet-ship Dreadnought holds his place, nevertheless, among the record-breakers of all time.

One is led to ask: Why so much desire for speed in those early sailing days? When it is recalled that there were then no transcontinental railways and no well-developed steamboats, and that the demand for prof-

itable exchange of goods between the Far East, South America, and our own west coast was very active, the reason for the high development of the sail-boats becomes apparent. Those were the days of the gold strike in California and of highly competitive trade with China, the Indies, and foreign ports. With the advent of economical railway transportation and commercially practical steamboats, the clipper ship gradually passed into disuse.

In considering the speed of the fastest voyage we are not so very far ahead of the old sailing-ship days, but one cannot always count on the most favorable weather conditions, and wages, interest on the investment in ship and cargo, and insurance ran on whether the voyage was quick or not. Steamers are comparatively independent of wind and weather. A modern liner can carry more than five thousand people on a single voyage, and as much freight as a train of freight cars forty-four miles long. And in addition, although it is perhaps merely incidental, she affords her passengers such luxuries as the most extravagant im-

agination of an old-time sailor could not have dreamed of.

We have bridged a tremendous gulf in the years between the great voyage of the Santa Maria, ninety feet in length and twenty feet in beam, and the launching of the Vaterland, —now the Leviathan,—nine hundred and fifty feet in length and one hundred feet in beam. The capacity of the Mayflower according to an old record was "100 tuns." A tanker launched not long ago had a capacity of approximately five thousand tons dead weight. The savage carried a few hundred pounds in his dugout or his birch canoe — say three hundred at a rough estimate — some forty miles in a day. This makes the equivalent of twelve thousand pounds for one mile or six ton-miles. Whereas the freighter, with a crew of, say, twenty men, running during the entire twenty-four hours will carry five thousand tons two hundred and forty miles, or accomplish sixty thousand ton-miles a day for each man on board.

It is hard to comprehend the immense part that the automobile plays in solving

the transportation problems of to-day. People twenty-five or thirty years old can remember when whole towns turned out to see the first automobile to pass that way, a curious high-wheeled affair, steered by a tiller and built for all the world like a bobtailed buggy. Yet in 1920 there were 7,904,271 automobiles in use in this country alone. How the production of automobiles in 1899 — it was 3700 cars valued at $4,750,000 wholesale — would have amazed the men who built the first steam locomotives, which really were the first automobiles! Yet from that production, which seemed so big in its day, we have advanced to 1,586,787 passenger cars, worth at wholesale $1,399,282,995 in 1919, and 305,142 trucks, worth $408,311,585. More than $6,000,000,000 of capital is invested in automobiling in the United States. The depreciation in the value of cars costs the country, it is estimated, $1,829,000,000 a year. We use 2,178,729,000 gallons of gasoline a year, for which, were the price only twenty-five cents a gallon, we should pay $554,682,250. For oil we pay in a year,

$729,280,225; for tires, $1,000,000,000; for State license fees, $65,000,000; and so on, until our annual bill, thus estimated, foots up a total of more than six billions. And in addition to this we spent for good roads in the year ending June 30, 1919, more than $61,628,000, which should be charged in part to the expenses of automobiling.

New developments in transportation may mark the present era. Already many of our cities are underlaid by a series of pneumatic tubes by which mail is sent from station to station. We had an experience during the war when a German submarine, submerging to avoid observance, made its way to the United States, sold its cargo, and took on another. It is possible that very soon we shall see aerial freight service. Already it has been proved practical for passenger purposes, and there are regular trips made now between London and Paris. An enterprising firm is said to have actually transported a grand piano in an airplane, for purposes of advertising. If any one wants to take a journey into the future, let him read Kipling's story "With the Night Mail," in

which is pictured a possible aerial service that may be hesitating just behind the scenes of the world stage, waiting for its cue to step on and make its bow.

In a day when airplane mail service has lost its novelty, when airplanes as instruments of war have taken a place so prominent that the air service has become a part of every national military and naval establishment, when man has risen fully seven miles in the air, has flown across the Atlantic Ocean, and in an airplane has crossed the continent in twenty-two hours, it would be difficult to exaggerate the future importance of flying as a means of transportation.

It is hard to overestimate the part that transportation plays in our civilization. All of the cities depend on transportation for their existence; the food of the people is brought in to them from the country. The manufactured articles are taken out to the country or to other cities and often to other countries for sale and use. In fact, the power to transport products is the essence of that specialization that we have seen going on. It makes civilization possible.

It follows, therefore, that sound economic development will be most rapid where the means of transportation are best and cheapest. The reason why the United States has outstripped most other countries in its economic development has been the comparative excellence of our railroads and the cheapness of the rates they charged. About ten years ago there was a big general attack upon our railroads by the public and by the Government, National and State. Unwise people led by unwise leaders decreed all sorts of limitations upon the freedom of the lines, and created commissions that imposed conditions so hampering to the railroads that many of them ceased to operate at a profit. The securities of these companies fell off sharply in value and in public estimation, and people no longer cared to invest in them. The country kept on growing; it needed additional facilities, — cars, tracks, bridges, locomotives, and stations, — but there was no way of raising the money to pay for them; and so with the period of need coming toward us, the great World War looming large in our faces, we were forcibly starving

that part of our organization, our transportation system, upon which our very lives, yes, civilization itself depended.

That day has passed and people are now beginning to realize that they can't draw off the blood from their circulating system and expect it to thrive, and gradually we shall see transportation restored to its rightful place and jealously protected and fostered by all — Government, citizens who ride, and also the laboring man himself, who will come to see that his means of cheap transportation is his best friend.

So here we come to the end of our story. We find ourselves living in a world where trade is so easy that we brush our teeth with bristles brought from Siberia, eat sugar from the tropics and pepper raised in Sumatra or the south of China, wash with soap made in part of materials that come from Sumatra and scented with herbs from France, and wear shoes made of leather from the Argentine. We carry money of silver from Bolivia; our teeth are filled with gold from Alaska. We wrap ourselves in furs brought from Labrador and wear a watch made in

Switzerland of steel from Germany and gold from South Africa. In fact, everything we wear and use is probably carried anywhere from ten miles to twenty thousand miles, and is the product of so many processes that we are utterly at a loss to know its origin. If we wanted to go through to the bottom of our daily comforts, we should find it perfectly impossible to trace them — so many and so scattered they are.

This has transportation done for us!

VI

THE STORY OF ELECTRICITY

The part that electricity plays in our life is so vital and important that I cannot leave it out of this book. I have lived long enough to see the science of electrical engineering form and grow to its present magnitude, and, though I use electricity for my daily purposes with absolute freedom and with very little thought as to what it all means, just as most of us do, I have to reach out and get the assistance of experts to tell the story of electricity, even to a greater extent than I have in the earlier chapters. A brother versed in scientific matters has helped prepare much of this material, and my good friends Stone and Webster, electrical engineers, have contributed, as have also officers of the American Telephone and Telegraph Company. I have emphasized the development of the telephone partly because of its intrinsic interest and partly because my father was the president of one

of the original companies and helped carry this business through some of its most difficult stages.

Incidentally, let me say that when each of these chapters was started, I knew as little as my readers do about many of the technical subjects treated and have been as much surprised as anybody at the arrays of facts and figures that have been assembled in their development.

Man's power to take advantage of the forces abundantly provided by nature, either wholly unobserved or faintly understood, has been growing with such a rapid pace in the last few years that, from week to week, marvelous advances occur that are not more than half realized or half comprehended even by those of us who benefit most by the discoveries. Further understanding, for instance, of the chemical composition of the world and the manner in which the various substances which we see and touch are compounded, and of how to disintegrate them into their component parts and combine them again in new forms which serve man's uses, are matters in which

progress is being made too rapidly along too many lines to come within the comprehension of any one of us.

Of these forces, electricity, the subject of this chapter, has come to play such a marvelous part in our lives that most of us wonder how we got along without it; yet, within the memory of persons still living, electricity was used hardly at all to serve man's needs. It was seen in the lightning; it was often recognized; our parents as children undoubtedly shuffled across the floor, just as we have, to get a little electricity in their systems and feel it spark as they touched the doorknob or grandpa's bald head; but nobody understood it. Just think how many millions of the human race, throughout the long centuries during which paleontologists tell us human life has endured, have stood watching the play of lightning in the clouds, and then think that none of them ever dreamed that the same agency that so manifested itself could be made to carry messages, transmit talk and laughter and song, light us by night, warm us in cold weather, cool us in hot weather,

carry us about, lift us in the air, and do all the other bits of service which man has found for it. Two or three centuries ago anybody who presumed to be able thus to use the elements would have been charged with witchcraft and hanged.

But how was all this done? How is electricity tamed? How transported about and changed into light, heat, and motion? How came it that we learned to send messages with it, first over wires and then out into the circumambient atmosphere, and how to pick these messages up again and make them so that they can be read or heard? All of these things are comparatively recent developments and we are still being astounded with new uses and new devices.

The ancient Greeks knew that when amber was rubbed, it would attract small objects, much as a magnet will lift a needle from the table. "Elektron" was the Greek name for amber, and hence the word "electricity." Rub a hard-rubber fountain pen on your sleeve, then hold it very close to a tiny scrap of paper lying on the table and you will make for yourself an observation

which constituted practically all that the ancient Greeks knew of electricity.

In 1600 William Gilbert published a great work on electricity and magnetism in which he recognized the distinction between the electric attraction of amber and the attraction of a steel magnet for bits of iron. In 1752 Franklin flew a kite under a thundercloud, with a common key suspended where the hempen string gave place to a silk cord held in his hand. He found that electrical effects could be produced by the key, and showed in this way that lightning was only another manifestation of electricity. In 1786 Galvani found that frogs' legs cut from a frog just killed and hung by a copper wire on an iron balcony twitched convulsively whenever the flesh touched the iron. Though the frog as an organism had been killed, the nerves and muscles were still alive, and it needed only a small current of electricity to excite them.

Volta soon afterwards showed by experiment that the current which made the frogs' legs kick came from the contact of the two different metals, copper and iron, with

the moist flesh and with each other where the wire was fastened to the iron, thus forming an electric circuit. From this discovery (and the voltaic cell which followed it) there came the development of various kinds of batteries, all of which depend on placing two different metals in solutions of acids and salts and obtaining an electric current from the chemical action which results. The common dry cells which we use to provide the spark for a gas engine in an automobile or motor boat, or to light a pocket flashlight, are the direct outcome of this development.

In 1820 Oersted discovered that a magnetic needle, when placed near a wire through which an electric current flowed, was deflected by the presence of the current. Just a century ago, in the year 1821, Michael Faraday, following the clue given by Oersted, began to lay the foundation for our present understanding of the relation between the electric current and magnetic force. Ten years later he succeeded in causing an electric current to flow in a circuit by merely changing the magnetic forces in its vicinity.

It is said that when Faraday took a man of affairs into his laboratory and showed him this experiment, his visitor said, "What's the use?" to which Faraday answered, "What's the use in a baby?"

Let us see what this baby has grown into. The direct result of this observation was the invention of the dynamo or generator, a machine which turns mechanical energy into electrical energy. By rapid shifting of large magnetic forces in the wire circuit it creates an electric current.

In an earlier chapter we saw how the miller built a water-wheel and thus used the power of the stream to grind his corn. But he could use his power only on the spot. Now the development of Faraday's idea has brought it to pass that we can go into the mountains far from the cities where power is needed and, building a great water-wheel, make it drive a dynamo which will send vast quantities of electrical power over wires to the distant places where it is needed for the various purposes of civilization. Whole cities have sprung into being as a result of water-power so used.

So in the present era the "baby" of Faraday is a giant — grown immeasurably. To give some idea of this I have secured a description of what is probably the largest and most interesting hydro-electric power station in the world — one built on the Mississippi River at Keokuk, Iowa. At first sight of these mammoth works one is struck by the way in which they harmonize with their natural surroundings; only, by degrees, comes a realization of the enormous scale of the development, and, finally, overshadowing all other impressions, one is filled with admiration for the human resourcefulness that has made possible this achievement.

The plant is laid out in the form of the letter "L," the longer leg lying crosswise of the river from the Illinois shore to a junction with the shorter leg, which extends downstream from a point near the Iowa side. The longer leg represents the main dam, the shorter leg, the power-house, which itself forms a part of the dam, holding back the water in a space called the forebay, closed at the downstream end by a huge lock, through

which the river steamers pass from one level to the other. The main dam allows the escape of all water not needed for the generation of power. The water passes through the openings in the power-house section and operates the great turbines. If we were to walk from the Illinois shore the full length of the concrete structure across the deck of the dam to the power-house, through the latter to the lock, then across the lock to the Iowa side, we should cover a distance of more than two miles.

The city of Keokuk is situated at the foot of a natural drop in the Mississippi River, formerly known as the Des Moines Rapids. Here the river flows through a comparatively narrow valley and over a firm rocky bed. The natural advantages of this site have made possible the only development of the greatest of American rivers from its headwaters in Minnesota to the Gulf of Mexico. In place of the former rapids we now find a broad lake extending sixty-five miles above the dam. Roads, railroads, and homes were moved to make room for this lake. The flow of the Mississippi River here is drawn from

an area of 119,800 square miles, or a tract greater in extent than the combined areas of the six New England States plus New York, New Jersey, and Delaware. Under conditions of average flow 65,000 cubic feet or 2000 tons of water pass through this plant every second. The average head is thirty-two feet. For use when the natural flow of the river is at a minimum, 19,400,000,000 cubic feet or 325,000,000 tons of water may be stored and drawn upon as needed.

The dam proper is firmly fastened to the solid limestone of the river bottom by means of steel rods, twenty to thirty feet long. The main dam or spillway section, as it is called, consists of one hundred and nineteen arches which are provided with steel gates eleven feet high and thirty feet wide, for the purpose of regulating the flow of the river. They keep the water at the same height at all times, from extreme low water, when every gate is closed and all available flow is passing through the wheels, to the highest known flow of the river, when the one hundred and nineteen gates are wide open.

The present power-station is nine hundred feet long, occupying one half of the completed sub-structure. Some day it will be extended to cover the entire sub-structure, thus doubling the present plant.

Inside the power-house are fifteen huge electric generators in a single row running the entire length of the building, each having a capacity of about 10,000 horsepower or a total of about 150,000 horsepower. Each generator is thirty-one feet in diameter and eleven feet high and weighs one million pounds. Down in the substructure of the building, directly beneath, is the water-wheel, or turbine, that turns it.

The rotating portion of each of these generators weighs 500,000 pounds or as much as one of the largest passenger locomotives. When we consider fifteen of these units operating simultaneously, we have a revolving mass of 3750 tons, comparable in weight to a fair-sized steamship. Out of every one hundred units of energy given up by the water as it passes from the higher level of the forebay to the lower level of the tail race, eighty units are

converted into electricity. This is another way of saying that the efficiency of the plant is eighty per cent.

From the generators the electric power passes through oil switches, capable of instantly cutting off the flow of current in emergency, to the "bus," the latter being nothing more than a set of copper bars to which both the generators and the outgoing transmission lines are connected and which acts as a clearing-house for the electric power generated. From the "bus" the outgoing power passes through step-up transformers to increase the pressure from 11,000 volts to 110,000 volts for economical transmission to St. Louis. There are fifteen of these monsters, each of which weighs 246,000 pounds and contains 10,000 gallons of insulating oil.

The Keokuk works, as they now stand, cost in the neighborhood of $30,000,000. In their construction there were used 289 tons of dynamite, eight million feet of lumber, and 2,832,096 sacks of cement. The material used in actual construction reached a total of 2,297,260 tons. This material, if loaded into standard railroad cars, twenty tons to

the car, would make a train more than one thousand miles long.

The enormous machinery of the power-station, which has eight times the floor space of Madison Square Garden, is controlled from the room in which the operating switchboard is located. The chief operator has before him a diagrammatic model of the entire generating system, showing him instantly and automatically what is taking place at any point. From his desk by means of remote control devices, each a wonder in itself, he mobilizes the mighty forces of the Father of Waters and directs their disposition.

From a steel structure on the roof of the power-house a half-dozen copper wires slightly less than an inch in diameter stretch out across the water and disappear into space. Far on the other side of the river one can see the huge steel towers that carry them on their way to St. Louis, Missouri, 144 miles down the river. Between Keokuk and St. Louis the transmission line crosses the Mississippi River twice and the Missouri once.

Another main transmission line extends northward from Keokuk to Burlington, and many way stations are supplied from both lines.

The copper used in these lines, if drawn into a single wire of the size used for telephone connections, would reach from the earth to the moon. The conductors are supported by 1062 steel towers varying in height from 80 to 260 feet.

At the outer ends of the transmission lines the electric power is stepped-down through other transformers similar to the step-up transformers at the power-plant. The enormous stream of electric energy is divided and subdivided, measured and reshaped into a multitude of different forms, but always flows steadily in its predetermined channels to serve the homes, factories, and offices of more than a million people.

The power sent out from this Keokuk plant displaces many steam engines and boilers and saves each year about one million tons of coal, valued at the present time at about ten million dollars. The falling water turned into electricity takes the place

of the black coal burned under the boilers and so has acquired the name of "white coal."

These figures give some idea of the size to which the Faraday "baby" has grown — so huge that it dwarfs any of the djinn or giants conjured into existence in the fairy-tales of our childhood. Thus we see furnished the electricity that lights our houses, runs our street-cars, turns the wheels in the factories, and does the thousand and one errands or services which we have come to require of it; and of course it is many times more economical to have one big central power-station than to have a thousand little plants scattered about at the points where the current is used, as in the street-cars, the mills and shops, and the dentists' parlors.

The water-power plants already installed in the United States and used for generating electricity have a capacity of ten million horse-power and the power-plants run by fuel a capacity of double that amount — a total for the two classes of thirty million horse-power. But we have hardly begun to

use our "white coal" yet, as is indicated by the fact that the undeveloped water-power in the United States is estimated at fifty million horse-power. A little figuring reveals that for every person in the United States there is an electric generating capacity in the plants already installed of about three tenths of one horse-power and for every dwelling about one and a half horse-power — thus multiplying the power of each individual reached several times over. Fifty-seven per cent of the population is reached by central stations and thirty-one per cent of the dwellings are electrically lighted.

The electric motor, which is the direct outcome of Oersted's discovery, is the exact opposite of the dynamo. It turns electrical into mechanical energy by using the force of electro-magnetic attraction and repulsion. It should be understood that a properly designed dynamo can be used as a motor and *vice versa*.

An interesting series of experiments revealed to the early scientists the rules under which the flow of electricity is measured.

The volts, named for Volta, represent the

force which drives the current. The ohms represent the resistance to be overcome. Ampères are the units of the resulting flow of current. The relation of these units may best be visualized by comparing the electric current to a stream of water flowing from one tank at a higher level to another below. The difference in level which determines the head of water, or pressure, is closely analogous to the volts. The resistance of the pipe through which the water must flow is comparable to the resistance of the wire. The resulting flow of water in terms of cubic feet per second is exactly comparable to the ampères of electric current.

The step-up and step-down transformers, already mentioned, are additional results of the researches of Faraday and Ampère. They found that if a current flowing in one circuit is altered, a current is thereby set up or "induced" in another circuit near by. Now if a current were generated by the dynamo at the power-house at a voltage or electrical pressure at which it is safe to lead it into a private house, in order to bring it from the power-station to the house without

prohibitive loss in transmission we should have to use wires so large that tons and tons of copper would be needed for even a few miles, otherwise too much of the power would be used up in overcoming the resistance of the wires on the way, and little would be left to light the house. If the power were generated at a voltage high enough to travel over small wires without excessive loss, it would be too dangerous to bring into the house; the inhabitants would be in constant danger of fire and electrocution.

Now, by building a transformer made of soft iron and coils of copper wire properly designed and arranged, it is possible to bring the current at high voltage over the small wires, and then, at a safe distance from the house, induce in another circuit a current of the same power, but at a lower voltage, which may be safely led into the house for lighting and heating. You have doubtless seen black objects at the top of the pole on the street in front of the houses in suburban districts. These are transformers.

Another development of the voltaic cell is seen in the storage battery, into which can

be "poured" electric current generated by the dynamos when the load is light, to be drawn upon when the load is heavy, as at about six in the afternoon when lights begin to go on and street-car traffic is heavy with people returning from their work. Electric automobiles are machines of great convenience and dependability, driven through the agency of storage batteries. And even automobiles driven by gasoline would be utterly helpless without their electrical equipment. Every first-class car has in it two dynamos, a storage battery, and a motor. The magneto, which is only a dynamo with a fixed magnet for its field, supplies the current which makes the spark that ignites the gas. The other dynamo or generator keeps the battery charged, and the motor is used to start the engine. Thus each car has a complete electric-power system in miniature.

The Chicago, Milwaukee & St. Paul Railroad operates by electricity for several hundred miles on the western end of its transcontinental line. Huge engines, more powerful than any steam locomotive, take

the trains comfortably right up the mountains and down. These electric engines can haul one hundred and twenty cars up a fair grade. One of them has pushed back two powerful steam engines pushing in unison against it. When going downhill the motors are changed into dynamos and pour the current back into the wire.

One of the most remarkable applications of electricity to the service of mankind is the telephone. Forty-five years ago, in a building which stood at 5 Exeter Place in Boston, the human voice was for the first time transmitted electrically. These first words were spoken by Dr. Alexander Graham Bell, the inventor of the telephone, and were heard by Thomas A. Watson, his assistant. The crude telephones with which they were experimenting were placed in two rooms some little distance apart in the same building and were connected together by an electric circuit. Years had passed in experimentation, when finally on March 10, 1876, in a most historic moment, the apparatus transmitted a message from Dr. Bell to Mr. Watson. Bell, having accidentally spilled a

bottle of acid, spoke into his transmitter the words, "Mr. Watson, please come here. I want you." To Bell's intense astonishment and delight, Watson came rushing in at once from the other room where he had been listening at his end of the circuit. It was thus that the first spoken sentence was electrically transmitted and heard over a wire.

The early telephone instruments which Bell designed consisted of an iron reed placed just in front of a magnet around which was wound a coil of wire. When the vibrations of the sound waves of the voice impinged upon the iron reed, it was caused to vibrate in such a manner that it closely imitated the vibrations in the air. The motion of the reed in front of the magnet generated a delicate electric current in the coil. This current, after flowing over the telephone wire, proved capable of exciting motion in the reed at a receiving instrument, thus causing it to produce sound waves exactly like those spoken into the first instrument: a further application of the principle originally discovered by Faraday. The first out-of-doors telephone line was about

two miles long and extended from Boston to Cambridgeport.

It is difficult for the imagination to grasp the fact that from this simple beginning the telephone industry has grown in a few years until its wires form a web extending throughout every civilized nation. We cannot but wish that by some feat of legerdemain our vision could be so enlarged as to comprehend all the details of this wonderful growth

The story of the development and expansion of the telephone industry is one which cannot fail to arouse the pride of every American, for the art of transmitting speech electrically is a product of American effort more than of any other and reflects the genius of our people. It is a story of American enterprise and American progress. With few exceptions, the best that is used in telephony everywhere in the world to-day has been contributed by workers here in America.

The telephone was born into a world which had no dynamos or electric motors, no trolley cars or electric lights, no wireless telegraphs, no steam turbines, no gas engines,

no automobiles, and no professional electrical engineers, for none of our universities had up to that time offered electrical engineering courses to their students. When, forty-five years ago, the telephone was introduced to the American public, and when some of the great financiers and business men of that period looked upon it as merely an interesting curiosity with no commercial value, a small group of Boston merchants undertook its development. With wonderful vision and almost prophetic foresight and with the aid of American scientists, they laid the technical foundation and planned the business structure for the great nation-wide utility which it has since become.

The two telephone instruments used by Bell and Watson in 1876 have in the United States alone now grown to more than thirteen million, and the first telephone circuit one hundred feet long has developed into a system which operates thirty million miles of wire. This vast system reaches every city and practically every hamlet of the country, and each year carries an aver-

age of one hundred telephone conversations for every person in the United States.

In 1915 upon the achievement of that dream of the telephone pioneers — transcontinental telephony — Dr. Bell again talked to Mr. Watson with the two historic instruments of 1876, but this time the continent of North America separated the two men! At his instrument in New York, Dr. Bell repeated the first message, "Mr. Watson, please come here. I want you," but this time Mr. Watson, who was in San Francisco, could not comply with such alacrity, although he heard the tones of Bell's voice more clearly and distinctly than when he first heard the now historic words of his old associate.

During the same year in which the transcontinental circuit was placed in operation there occurred another epoch-making event in the history of the electrical transmission of the human voice. In September, 1915, by means of the wireless telephone the human voice was successfully transmitted from Washington eastward across the Atlantic Ocean to Paris, and westward

over land and water to far-off Honolulu, the latter a distance of forty-nine hundred miles. Two essential parts of this wireless telephone equipment were the transmitter and receiver of the standard telephone instrument. But for Bell's invention of the telephone which transmits the voice over wires, and the subsequent perfection of this device, there could be no wireless telephone.

One of the most extraordinary things in my experience was sitting at a dinner in New York as a guest of the American Telephone and Telegraph Company: at each place there was a telephone ear-piece, and Mr. Carty, who is the vice-president of the company in charge of experiments, called up first one station and then another across the continent. A wire burned to white heat indicated the passage of the waves across a map that was set up on the wall, so that we could all see just where the wire led through which Mr. Carty was talking. One station after another responded to its call, and finally he was talking to San Francisco, where some artist gave us a little musical selection for the pleasure of the guests. Then

we were further connected a few hundred miles south to Los Angeles and then by wireless to the island of Catalina. A few minutes later a steamer in the Atlantic Ocean was called up, and the guests heard a conversation between Mr. Carty, sitting at the table with us, and some one on the reeling deck. That person was then connected to the transcontinental line and the extraordinary feat was accomplished of conversation by wireless from the boat in the Atlantic to the wire connection thirty-seven hundred miles across the continent, and then by wireless out to sea in the Pacific to an island thirty miles from shore.

Although the telephone has accomplished wonderful things, we must not get the impression that its rate of growth is slackening. Just at the present day very important developments are taking place. Apparatus is being installed which will enable each telephone wire, which heretofore has carried only one message at a time, to carry five messages simultaneously without the slightest degree of interference. In the same way, single telegraph wires are being arranged to

carry fifteen or more simultaneous sets of telegraph signals. Then there are the wireless telegraph and telephone, supplementing but not displacing wires, which are steadily coming into greater use for the transmission of messages.

No one can tell how far away are the limits beyond which it is impossible to transmit the spoken word. But the spirit of the pioneers is alive in the minds and the hearts of the great American telephone engineers of to-day, one of whom has said: "I have faith that we shall some day build up a great world telephone system, making necessary to all the nations the use of a common language or a common understanding of languages, which will join all the people of the earth into one brotherhood. I look forward to the future with a feeling of confidence that the time will come, so eloquently described by the poet,

"Wherein each earth-encircling day shall be
A Pentecost of speech, and men shall hear,
Each in his dearest tongue, his neighbor's voice,
Though separate by half the globe."

One of the greatest scholars England has produced was James Clark Maxwell. He devoted his time to making mathematical calculations about the laws governing the forces of nature and in particular the behavior of electricity. A glance at some of the formulæ which he wrote would frighten most teachers of mathematics into closing the book with a shudder. The average man in the street could not believe that such formulæ could ever lead to anything useful. But Maxwell studied the discoveries of Oersted, Faraday, and Ampère, and reasoned about them with the help of his terrible formulæ, till he arrived at certain fundamental conclusions. In 1842 a man named Henry proved that when a body which is highly charged is made to discharge in the form of a spark, as when you shuffle across the floor and touch the brass bedstead, the current which flows in the spark oscillates back and forth, flowing first in one direction, then in the other, just as a spring or pendulum oscillates when released. But whereas the pendulum oscillates so slowly that you can watch it swing and count the

oscillations, the current in the spark oscillates with a frequency of many million times a second. Henry also found that a discharge of this sort caused a sort of invisible wave motion to travel off into space. Maxwell calculated the laws which must govern these waves and concluded that they travel at the speed of light (186,000 miles a second) and that they are essentially the same sort of waves as light itself, only differing in the frequency with which they follow each other through space, and consequently in the length of each wave.

These formidable calculations of Maxwell laid the foundation on which Hertz built when he made his experimental investigation of the waves which travel through space from an oscillating current. Tesla and others made great strides in learning how to produce these waves, and finally Marconi applied the finishing touch which made it possible to utilize the waves in a practical way for purposes of wireless communication. Perhaps to Maxwell, the mathematician, more than to any one, do we owe the great secret of radio communication.

Many readers are familiar with the "audion" as used for a detector in radio communication, but probably few know much of the wonderful story of its development. Years ago Edison observed certain peculiar effects which occurred when a filament is caused to glow in a vacuum as is done in the ordinary electric-light bulbs we use to light our houses. The effects were baffling to scientists and led to much speculation and experimenting. These men, among whom Fleming, of England, and Langmuir, of the General Electric Company, in our own country, are notable, investigated these effects, and, building their work on the great foundation laid by J. J. Thomson, of Cambridge, England, finally traced them to the fact that the red-hot filament throws out into space free electrons, the smallest particles of any sort known to science, and these may be made the vehicle of a current of electricity which may be conducted through the otherwise non-conducting vacuum.

The most impressive feature of this achievement is that most of these men were

impelled in their work by pure scientific curiosity. They had no thought of making any practical use of what they found. They merely wanted to know how the strange effects were caused, and why. Their spirit was that of an explorer who seeks new continents or oceans, lured on by the joy of the quest. But the laws they found have enabled their followers to design and build all the wonderful electron tubes or audions which are used to-day for a host of diverse purposes in the field of radio communication. The electron tube is responsible for the practical development of the radio telephone. From ships at sea we can now talk to other ships almost as easily as we can talk from house to house. The rapid scientific team-work of our sub-chasers in the war depended on the radio telephone more than on any other one thing, except the brains of their skippers.

In every phase of their operation these radio telephones utilized the electron tube. One type of electron tube generated the high frequency currents which are the source of the waves; another type modulated these

waves, thus making them the vehicle of the audible sounds sent out by the speaker's voice; by means of still another type, the incoming signals were rectified and made available for detection with the telephone receiver; and still other tubes were used to amplify the signals and thus extend the range of operation enough for practical usefulness.

In the field of amplification the electron tube performs its most brilliant feats. An incoming signal, far too weak to be detected by any other means, is led by wires to the so-called "grid" circuit of the electron tube; this exerts a sort of trigger action by which a much greater current, led from a battery through the "plate" circuit, is caused to fluctuate, and this reproduces on a much larger scale the original current. In this way the signals are amplified about twenty-fold. But this is not all; the current from the plate circuit is then led to the grid circuit of a second tube and amplified another twenty-fold, and the process is again repeated. The British developed a six-stage amplifier which has now become standard equipment in this

country as well. In this, signals are amplified to several thousand times their original strength, and by this means it has become possible to receive signals from fifty miles away and hear them plainly over the roar of four Liberty engines in a giant seaplane traveling at full speed.

The electron tube is so versatile that it will do almost anything you ask. It has invaded other fields besides radio telegraphy and telephony. It has revolutionized long-distance telephoning by wire. It has even been used to amplify currents arising in the nervous systems of animals and record with the aid of other instruments some of those which are too feeble to be otherwise detected.

Another interesting development of radio science is direction-finding. On shipboard or on shore it is possible for the operator, by merely rotating a coil as he listens to a signal, to tell the direction from which the signal is coming. With very little skill on the part of the operator readings are taken with these direction-finders depending on a difference in the time of arrival of each wave

at the two sides of the coil amounting to less than two-billionths of a second. The United States Navy, by installing direction-finding stations all along the Atlantic coast, has, in the two years since their installation, helped hundreds of vessels to find their way into port when the weather was thick and foggy.

These discoveries are going on so rapidly and so silently about us that we hardly seem to realize the magic of it all. I remember that when first the idea of sending messages by wireless was promulgated, to my practical mind the idea was utterly futile and absurd — messages sent off at random into the air — it seemed perfectly impossible. If more than one or two messages were sent out at the same time, it seemed to me that they would mingle with each other and make the reading of both messages impossible, and the vagueness of it seemed to me to condemn it. I dismissed it from my mind as a practical impossibility, and yet it has come along with steady progressive movement until now it has become one of the greatest factors of commerce and a necessity for military and naval purposes and also for

SHIPS IN DISTRESS, ON FIRE AT SEA OR LEAKING, SEND OUT A CALL FOR HELP

humanitarian purposes. Think how much safer travel has become as a result! Ships in distress, on fire at sea or leaking, send out a call for help, and soon steamers from various directions are racing to rescue the passengers and the crew.

Only a little while ago a most remarkable thing occurred. We all read about it in the newspapers. A steamer buffeted by an unusually heavy sea had several of the crew thrown so sharply against the rails and stanchions of the ship that they sustained a number of serious fractures of bones. There was no doctor on board. The captain did not know how to treat them. The men were in terrible suffering and the ship was many days away from the nearest port. The wireless sent out a call for help, and presently a steamer with a doctor aboard came racing to the rescue. But the seas were still so heavy that it was impossible to attempt the trip from ship to ship with any prospect of success. What was done? The doctor sent wireless instructions to the officers of the stricken ship and told them just how to treat each of the cases. The

symptoms were wirelessed back; the doctor diagnosed the trouble and sent a wireless which the size of the waves disturbed in no degree and which made the trip from ship to ship with a safety that the men could not. The vessel thus was able to proceed with her voyage and the men were saved great agony and perhaps permanent injury.

Now let us turn to a further development resulting from similar studies. We have seen how radio communication utilized those electro-magnetic waves which have wave-lengths much longer than those of light; let us now see what has been done with similar waves of a length much shorter than light. In 1895 Roentgen discovered that when a current is driven at high voltage through a tube with an incomplete vacuum — that is, containing still a small amount of gas — the stream of electrons coming from the cathode and striking the anode and the walls of the tube sets up electro-magnetic waves of the shortest wave-length known. These are the famous X-rays, and their most striking property is that they will pass through the human body or walls of wood, and are only

stopped by substances made of heavy atoms such as metals. When the human body is photographed by means of these rays, the bones, which contain heavy calcium salts, throw distinctly darker shadows than the rest of the body. By means of such photographs it is possible to determine the exact nature of a bone fracture, and thus to decide on the best course of treatment. The photographs will also show the location of a bullet in a wounded soldier, so that the surgeon may remove it without unnecessary cutting. Tumors and other maladies are more accurately diagnosed by the aid of the X-ray than they could be without it. To-day the X-ray plant is considered almost as essential a part of a modern hospital as the operating-room.

The most recent development of the X-ray tube has been made by Coolidge in the research laboratory of the General Electric Company, where he and Langmuir have collaborated in a wonderful organization of coöperative investigation. You will recall that the secret of electron emission from a red-hot filament was solved and then

made to serve a multitude of diverse purposes in the electron tube used in radio communication. This same phenomenon, electron emission from a red-hot filament, has been used by Coolidge in devising a new style of X-ray tube in which the penetration (wave-length) and quantity of X-rays produced can be varied at will and regulated with far greater precision than has been possible hitherto.

With this new development there is coming an increasing hope that the X-ray may perform a service in medicine possibly even greater than the diagnosis of fractures and other disorders. One of the most deadly of human diseases is the malignant growth known as cancer. Sometimes this can be removed by the knife of the surgeon and sometimes it is so placed that it cannot. Experiments are now being made to determine as far as possible the effect of the X-rays on these growths. We already know that X-rays, like the kindred gamma rays of radium, exert a somewhat selectively destructive effect on tumor cells. We must not look for too much in this difficult and dis-

couraging field, but there is some hope that with increasing knowledge of their action we may yet do something for the cancer patient that has hitherto been impossible.

So we come to the end of this brief study of electricity, having seen that an element which a few years ago was known to the world only as the source of strange and mysterious phenomena has now been harnessed to do a thousand services for man — to work for his comfort and convenience twenty-four hours a day, to save his life in storm, to bring hope in sickness, to entertain him in his home, to light the darkness of the night, and to make him master over the vast spaces of the earth. And having accomplished all that, man has not yet solved the riddle of electricity. In the years to come discoveries are to be made and new purposes found for this still mysterious force, and the service rendered to the world by those whose business consists of providing electricity or extending the scientific knowledge of its use is sure to be very greatly enhanced.

VII

THE STORY OF FINANCE AND BANKING [1]

It is the object of this chapter to set forth the nature and growth of that kind of service rendered to us all by those whose business is connected with finance — the banks, the bankers, and the brokers.

We return to our elemental community and find ourselves watching a development that comes after the people have begun to specialize, save, and lay something by for the future. Perhaps they have already learned to use crude metal coins, or perhaps their wealth is represented in important measure by the jewels and ornaments of their womenfolk. Each wants to safeguard his property. He might build a strong box and watch it, but that would leave him no

[1] It is a pleasure to acknolwedge with gratitude my indebtedness to Ray Morris, Esq., of Brown Brothers & Co., New York, and to the officers of the First National Bank, of Boston, for valuable assistance in the preparation of this chapter. — W. C. F.

time to make a living. He might hide his treasure away. That can be done, but who will find it if he dies? And if he tells any one else where it is hidden, some fine day he may wake up to find his savings are gone. So presently our ingenious man speaks up and says:

"Let us all put our interests together and build a strong box that can be watched by three people whom we select especially for their trustworthiness and who will serve to watch our property and watch one another."

And so they agree, and all their savings, or most of them, are put in the keeping of one agency that safeguards them for all. By combined effort they can build a much safer place than each one could afford separately; and by each contributing something, they can afford to hire people to watch it. Each member of the community now feels free to go farther afield in his work. His mind is at ease.

The first requirement of a bank is thus obtained, namely, security. If a man dies, his heirs know where to find his possessions, and the guardians of these things have their

instructions as to how to dispose of them. The business of these men is faithfully to guard the property of the rest; and the others, by increased devotion to their specialties, can earn enough more to pay them handsomely for it.

Now let us look at a second service performed by a bank. To make a striking if somewhat grotesque illustration, let us imagine our community as more civilized than when we first saw it, but still using measures of corn as its currency. Let us imagine that A, who is the butcher, wants to pay B, who is the baker, for the supplies received from him during the month. B is a vegetarian and does not eat meat. A loads up his cart with corn, swings the two oxen into the yoke, and laboriously goes four miles out into the country and delivers to B his payment in sacks of corn. B, the baker, has owed C, who lives in town and who may be the clothier, the confectioner, or perhaps the candlestick-maker, for things which have been due him, and he has been waiting for A to pay him before he pays C. So B hitches up his yoke of oxen, loads the

corn into his cart and puts in a day hauling the corn four miles back to town, delivering it to C, who has been visited several times by D, the doctor, who, liking the air of the country, lives four miles out the other side of the town. So once again another yoke of patient oxen are called out and C puts in a day hauling his corn into the country to hand it over to his friend the doctor, who has been waiting for this auspicious moment to pay for the meat he has received from A and for which the bill is some time overdue. So the doctor, instead of making his rounds on horseback as usual, hitches his horse to a cart, puts in the corn, and hauls it back to A, where it started. All four men have paid their bills and the corn is just where it was, a little the worse for wear, having been wet down perhaps one day when it was raining. There is a decrease in the quantity too, for some of the corn has dropped out through a hole in one of the bags. And four days' work of man and beast has been wasted.

One of the services rendered by a bank is the elimination of all this kind of waste. Even if corn were the currency, it could have

stayed in the granary and been represented by receipts. Each of these persons could have given an order on the bank for the money necessary to pay his bill, and the value behind the currency, whether it were corn or gold or silver, would have remained stationary while the slips of paper indicating ownership were passed about.

When our village has grown to a city and the number of persons concerned has increased from a hundred families to a million families, a place or series of places of common meeting to provide a method by which the bills can be paid is not only a convenience, but an imperative necessity. It is perfectly easy to see that people would have to go without most of the things that they now enjoy, as they would spend a very important proportion of their time hunting up and paying the people who made the things that they use if they had to carry the money, particularly if it were in bulky form, to arrange the payment. It is not too much to say that business as we do it to-day is made possible only by the facilities rendered us by banking institutions. They are an

essential part of our civilization, just as a link is an essential part of a chain; and if that link were taken out, the whole chain would fall apart, and our civilization in its present form would collapse.

Now let us take another service rendered by banks and see how that develops. This is to make beneficial use of their deposits. They put this money at work and it thus serves the purposes of the community a thousand times better than it would were it to lie idle. If invested or loaned, money can earn, let us say, six per cent, which, as we know, means that for every hundred dollars the owner gets a revenue of six dollars each year. And if that same money were to be buried under the house, the owner not only fails to receive that six dollars, but the community loses something besides, because the person who borrows one hundred dollars from the bank for his business and pays six dollars a year for it knows that he can make more than just that six dollars or there would be nothing in it for him.

What do we mean by putting money to

work, and how does it come to pass that a bank can do it?

Let us take a simple case. Suppose our village has one hundred families and that each family keeps its spare money in the bank. Some are farmers and sell their produce—fruit, vegetables, barley, corn, and wheat—as it is harvested, in the spring, summer, or autumn. Much of the money thus received will not be needed till the winter, when there are no more harvests and the expenses roll right on. Some deal in cordwood and coal and get their largest receipts in the winter. Others raise sheep or cattle and have wool to sell in the spring, and meat and hides at other times. Some work for wages and get their pay weekly and try to save a little against a rainy day. Suppose, just for example, there is an average deposit in the bank of one hundred dollars per family, or for one hundred families ten thousand dollars. The banks are unlikely to carry on their operations on so small a scale as this, but this will serve for the illustration. Experience tells the bank manager how much of the money it is

safe to lend and how much must be kept in cash. The laws under which our banks operate fix a minimum reserve of cash in hand below which the bank manager cannot go if he wants to keep out of jail.

Now let us see how the bank puts this money to work. We will say a ship comes in with a load of sugar and there will not be another for three months. The grocer wants to lay in a sufficient stock of sugar to meet what he knows will be the requirements of the villagers for that length of time, but he has money enough to pay for only half what he wants. He goes to the bank and asks for a loan and gets it. He has to pay interest to the bank on his loan and pledge some of his property to secure payment, but he can easily afford, from the profit he makes on the sale of sugar, the amount necessary to pay for the interest. The bank knows that it can safely loan the grocer the amount he needs. The grocer repays the loan when he has sold the first half of the sugar and so closes the transaction. This money thus loaned has rendered service to the community. It has assured them a supply of sugar

which otherwise they would have been without.

Let us take another illustration. One of our villagers cuts and stores ice for sale in the summer. But the cold spells are of short duration and to fill his ice-house he has to employ many helpers. He cannot do it alone in the time nature has allowed him before the next thaw. He has not money to pay these men and they unfortunately cannot wait for their pay till the summer comes and the ice is sold, for they need food and coal and clothing and other things that take money from day to day. He goes to the bank. He offers his house or his ice-house and its contents, and perhaps his horse and wagon used to deliver the ice, as security; insures the life of his horse with an insurance company, as the bank is very careful to see that its loans are properly protected; and borrows the amount necessary to pay for the labor that cuts his ice. In the summer he sells the ice for enough to repay the bank all it loaned with interest and also to provide himself with a nice profit, so that perhaps next year he will have enough

money to pay his laborers without having to borrow.

Carrying on the same principle, people's money while on deposit is made to build railroads and public buildings, provide funds to tradespeople, to farmers and manufacturers, and to help out all sorts of enterprises. Besides its deposits the bank has its own capital to start with. It puts part of the earnings that it gets from use of the money of its depositors into the business and calls it surplus, and the amount of the capital and surplus is enough to secure the depositors from loss if from an unforeseen reason some of the loans the bank has made turn out to be ill-advised.

In the first example of a bank's usefulness, we have the depositors paying something for the service they receive. But as the usefulness of a bank grows, we find it receiving and handling people's money and making no charge for it, as it makes a profit from the use of the money enough to pay all the costs of running the bank, and it even goes so far as to pay depositors something for the use of their money if the deposit be large and continuous.

The funds available for loaning purposes by banks are not, however, only the funds first deposited with the banks in the form of cash. The great foundation of deposits is loans, direct or indirect. When the merchant who wants to buy sugar gets his loan at the bank, what does the bank, in fact, do? It probably merely writes down the amount which has been loaned as a deposit in the merchant's favor. There would be, say, three entries in the case of an ordinary discounted note; on one side of the books the "avails" of the note would be credited to the merchant as a deposit; and a record showing that the face amount of the note was owed the bank by the merchant at maturity would offset it. To make these sums balance, it is necessary to add as "earned discount" a sum equal to the difference between the par amount of the note and the "avails" of the note, this representing the bank's profit. But the salient point is that, so far, no money has passed.

The merchant, if he pays for his sugar by check, is transferring to another individ-

ual, and very probably to another bank, the claim for such part of that bank deposit of his as represents the amount which the sugar costs. The seller of the sugar then deposits in his own bank the check thus received, and still no money has passed. Now, if we assume that we are dealing with two active commercial banks, it is probable that many transactions pass between them every day, and that only the balance of debits and credits is received by one from the other in settlement.

The net result of all this (and it is the essence of this part of the banking function) is that the amount of available bank deposits, which work just like currency in payment of obligations, is many times the amount of the currency in the country. The banks, in other words, enable us to do business on what we are going to earn, instead of on what we have earned already, and thus permit commercial growth on the basis of ascertained future needs, instead of on the slow basis of the exchange of currency based on past performance. But the process carries the dangers of its conveniences, and

the difference between good banking and bad banking is mostly measured by the control and regulation of credit machinery, which is where our important new development, the Federal Reserve Bank, comes in.

If a bank can be serviceable to people who live near one another and are within easy reach, how greatly multiplied is its service when its payments are to be made to people at a distance! And this service is still more accentuated if the money is to be paid in a country that has a different unit of value for its currency and does business in a different language. The bank has enough of these transactions to be able to afford to keep men familiar with the languages used by foreign people with whom their customers deal.

The old method by which trading was done is filled with the glamour that attached to the days of the clipper ships, the China and East-Indian trade, when interchange of commodities was slow and difficult and letters took half a year to go halfway round the world. In these days, when a cable can reach the same distances in half an hour, it

is hard to realize the difficulties of business in the old days.

A century ago the ships set forth from Boston or New York loaded with such of the products and manufactures of our Atlantic seaboard as could find sale in the ports to be visited. The goods were bought and paid for here and the ships set sail. There was no need of international banking operations, as each ship did her own banking. An officer known as the supercargo accompanied her and had charge of the goods with which she was freighted. The captain was also a merchant and business man. Arrived at China, he made his way to Hong Kong, or Canton, or Tientsin, or Shanghai, and unloaded. Chinese merchants crowded around and purchased his wares, or perhaps the owners of the vessel maintained a house there and his vessel's supplies were placed in the warehouse and thence sold to the local merchants in small quantities or in bulk, according as seemed best at the time. All this involved a good deal of judgment. Perhaps the owners had miscalculated the market and shipped too much of some one

commodity. Perhaps they knew that another ship was on the ocean headed that way with a still larger supply of the same goods. Often the whole success of a voyage depended on the speed of the ship and her ability to get to port ahead of other vessels trading in competition, thus giving her a chance to take advantage of some favorable condition of the market. Sometimes these cargoes had ready sale at good prices, and sometimes the sale was retarded; or perhaps the ship was sent on to some other port where there might be a better demand.

But suppose that the cargo has been well selected and is all absorbed by the market. What then? The money received is immediately paid out in the purchase of other wares, silks, teas, and perhaps porcelain ware. The ship is loaded and starts. No large amount of money for sale of merchandise is needed to be carried by the ship — only goods. The ship carries only enough money to pay for expenses of the voyage, such as the wages of the crew and the food and supplies. Even in the Chinese port, let us call it Shanghai, there may be

little passing of money. The same merchant who takes the American-made cargo will pay for it in bales of silk or cases of tea, and the only money that passes is the difference in value between his purchases and his sales.

My grandfather went to work at the age of fifteen years in the counting-house of his uncles, Messrs. Perkins, of Boston, who had a China business. One of the practices of those days was to let the officers of the ship, and sometimes ship's clerks, have the "privilege" of a little space, free of freight, in the ship and to allow them to undertake what they called "adventures." They could buy on their own account and at their own risk a supply of goods, silk scarfs or shawls, jewels, lace, or perhaps some of the rare vases from Satsuma, a little tea, or raw silk, and this they sold for their own account either at the home port or at some of the ports that the ship visited on the way home. My grandfather as a small boy had several of these "adventures" and made a thousand dollars as a result of these operations by the time he was seventeen years old.

Sometimes, of course, these voyages were

more complex, and instead of loading for one port a ship carried cargoes for three ports in as many different countries. If at each of these places the value of the sales equaled the value of the purchases, no money was needed; the transactions "washed" each other, as it is now expressed. But when there was a balance owed or owing, the shipmaster had to make arrangements with some bank or banking-house, or make up the difference with silver or gold.

Let us take a very simple case. Thompson, living in Boston, wants to buy some coffee raised in Brazil for his grocery stores, and Brown, of Lynn, wants to sell some shoes in Rio de Janeiro. To reduce the transaction to its simplest terms we will suppose that the values concerned are equal, say one thousand dollars of each commodity. Thompson and Brown do not know each other and have no way of getting into touch. But both know the bank and ask its assistance, and the bank makes a transaction very advantageous to all parties. It takes Thompson's money paid for the coffee and gives it to Brown in payment for his shoes,

and notifies its agent in Brazil of this transaction, and the agent in Brazil collects the same amount from the shoe-dealer in Rio and pays it over to the coffee-planter in São Paulo. The transaction is not quite so direct as all this, as in between there are a number of other transactions involving insurance, freight charges, bills of lading, warehouse receipts, etc., all of which care for the value of the goods during the period they are on the water and for the cost of handling and moving them.

When the values are not the same, the transactions are similar, but compound instead of simple. That is, there may be on one day fifty concerns interested in trying to get money to Brazil, and perhaps as many more trying to get money from Brazil. Their operators patronize different banks, but usually only a few of the larger ones specialize in this sort of business and so it is a simple matter for one bank to telephone around to some central source of information for quotations: "I want money in Rio. Can you let me have it?"

The rate of exchange, as it is called,

responds very readily to the law of supply and demand. If much more money is needed in Brazil than in North America, an effort is made to find some other way of getting the balance restored. For example, Brazil may be marketing her coffee crop, of which she sells annually about 12,000,000 bags at 132 pounds per bag, valued in 1919 at more than $36,000,000, and yet at the same time Brazil may be purchasing railroad equipment in England and rails in Belgium. Instead of having money sent from the United States to Rio to pay for coffee and then shipping this same money to Europe to pay for purchases there, Brazil arranges by cable with the banks to send the American money to Europe to pay Brazil's debts there. Perhaps, however, it will be found that no money may be needed for the transaction, as it may be that England wants to pay the United States for wheat shipped from Minnesota, and Belgium may be desirous of paying interest on a loan its Government made from ours; and so the banks manage to bring it to pass that each party gets his proper payment and that the actual transfer of cash is re-

duced to a minimum, just as in an earlier example we see the operations of the bank preventing the necessity for the laborious delivery of loads of corn from house to house.

Think what a tremendous service these triumphs of commercial and financial art have rendered mankind! In the first place, the transfers of cash are avoided and the exchange is made in an hour by sending and receiving a cable. All chance of loss is eliminated, for if the cable goes astray another is easily sent. Besides saving the cost and risk of sending money, there is saved the interest on it during its period of transit when it is, comparatively speaking, useless.

In the chapter on textiles we showed how the services rendered by the bank helped out the cotton-grower. In fact, it was explained how it made it possible for him to carry on his business, even though it is done indirectly and without lending the farmer a dollar. That is, the bank lends money to the grocer and the dry-goods man, who in turn let the farmer supply his needs on credit, as it is called; that is, they allow him to delay

paying for the things he uses until his crop is sold. So in every step of finance the bank helps out. It helps the farmer, the tradesman, the broker, the railroad that transports the raw or unmanufactured and later the finished product, the manufacturer and the ultimate consumer. It takes money that otherwise would be held idle waiting for future use and makes it work.

We have supposed the case of a small bank in a village merely to illustrate the nature of a bank's service. Let us now take the case of a large bank in a large city and get some measure of the extent of the service it renders. One of the largest banks in Boston has 15,000 depositors, with total deposits of $150,000,000, or an average of $10,000 per depositor. It has a capital of $12,000,000 and a surplus of $20,000,000, which means that $32,000,000 has been paid into the treasury with which it can conduct its business and add to the security of its depositors. It has 9000 stockholders.

Let us carry our observations a step farther and see what this service means when extended to the whole United States.

In 1920 the clearings of the national banks of the United States, which represent the transfers of funds between banks, largely for the accounts of customers, amounted to over $451,000,000,000. This means that on every business day of the year about $1,500,000,000 was transferred. The deposits in the national banks at the close of 1920 amounted to about $13,867,000,000, from which it is apparent that the money on deposit was turned over about thirty-three times in the course of the year, which does not indicate any idleness. The loans outstanding at the close of 1920 aggregated $12,311,500,000. The nearly 7800 national banks last year had $1,118,600,000 capital and nearly $1,000,000,000 surplus; and these figures do not include the State banking institutions, which reported deposits of about $6,500,000,000.

Yet mere figures only suggest the magnitude of our system of banking, for there is no way to show adequately the tremendous range of the services that it renders, and it is impossible for us fully to realize the desperate straits in which we should find ourselves if it were to collapse.

VIII

CAPITAL AND LABOR

In the first article of this series, in which we described the workings of a primitive village, we told about the first man who developed the foresight to plant more corn than he needed for immediate use and thus became the first capitalist. We later saw the further growth of capital, when the miller built his mill, and the engineer, the waterworks for the town; and we continue to see it in the creation of all businesses.

The possession of foresight is one of the signs by which you can tell civilized peoples. We pointed out the great power which came to the man who had enough corn to supply his village with food in case of shortage in the following year, and which was essentially a power for good, — namely, to relieve starvation, — although it might be turned into a power for evil if the man who had the corn abused his advantage and tried to deprive people of their tools and means of

livelihood, or of their children to be used as slaves, in payment for their food.

We saw that the villagers finally learned to protect themselves against this sort of extortion by making laws and taking further protective measures.

In that article we laid down the principles that really underlie all business: that a trade is a good trade only if it is good for both parties, and that people should seek only what is fair and just.

As civilization has progressed, capital has reached the enormous proportions of the present day. It is no longer a case of one farmer with a few extra bins full of corn, but of vast corporations capitalized at many hundreds of millions of dollars, employing hundreds of thousands of laborers and producing millions of tons of products which are needed for the business and even the lives of millions of our citizens. It is not the service of a simple community that we are now considering, but the service of a whole nation whose corporations send some of their products over the seas to serve other, far-flung peoples. But the magnitude of

the operations does not change the underlying principles one little bit. The power is there, and the same possibility to use it for good or evil.

Nobody who has read this series of articles can fail to realize that these operations have resulted in great good. We get a great deal more and better quality of the things we need for infinitely less money. The whole story of our business development, which reads like the magic of a fairy tale, brings it to pass that things which, almost within the memory of living men, were once luxuries reserved only for the occasional use of kings, such as many of our imported articles, especially sugar, coffee, and fruits grown in far countries, have become so easily obtained, and at such a moderate price, that they have come to be regarded as necessary for people of even the most moderate means. The poor man of to-day can have running water in his house, books, newspapers, medical service, and many other privileges which were beyond the reach of even the Emperor Alexander or the Pharaohs of Egypt.

Let us see how the operation of some of the companies that produce these results affects the individual man in his daily life. Take, for example, the marvelous progress that has been made in turning out shoes by machinery and the improved methods of treating and handling leather. The result is that people of the class that used to go ill-shod or barefoot, even in cold and bad weather, now can afford good boots. Let us take the case of a man with a moderate-sized family. He works, let us say, three hundred days in a year. Let us suppose that it takes eighteen days of his time to earn money enough to pay the cost of the shoes for his family. And now let us suppose that some of these combinations of capital, working incessantly in their efforts to improve their processes, devise a further improvement in business method that reduces cost of shoes to one third of their present price, and at the same time finds ways of treating the leather that makes it last three times as long. What a great service this company will have performed for the people! They now get three times

the value in their shoes for one third the price; in other words, they are nine times better off than before, which means that the laborer, instead of working eighteen days for his shoes, now needs to work but two days. This is not at all far-fetched. There are hundreds of articles of daily use, such as watches, tools, and many articles of food, which, upon analysis, will show results as extraordinary as this, and there is every reason to believe that this process will go steadily on.

We have spoken of the great power for good that these great combinations of capital exercise and have exercised. But there is also, simultaneously, a great power for evil. This power for evil is similar to that held by the man who had in his hands the food-supply and tried to abuse his powers and work injury upon his neighbors. So with our big corporations, while in the main their service has been great and they have made our civilization and our growth possible, yet we have to admit regretfully that some of their actions were unwise, some were unfair, and some absolutely improper.

When our fathers formed these United States into a nation and framed the Constitution and laws under which we live, they had never had to deal with any problem of this sort; there were no transportation facilities upon which the colonies had to depend for their necessaries. It was only with the growth and construction of railroads, steamships, and other means of transportation, and of machinery, banks, and all the rest of the things we have been describing, that these developments became possible. So the necessity of regulating corporations had not yet come into existence, and our laws made no provision for meeting the problems which soon were to face our young Republic.

Some companies used undue influence, and even money, to secure legislation favorable to them, but not favorable to the public. Capital became arrogant and inconsiderate of the rights of others, and far too many corporations adopted an attitude expressed in the words, "The public be damned," used by a railroad president of so little vision that he had not grasped the real

significance of the duty of the railroad, which is to be a faithful servant of the public. But the worst failure of capital and its most serious offense against the rules of fair play are to be found in its treatment of labor.

Capital profited largely and big fortunes were accumulated, but many companies were operated with an unscrupulous disregard of the public welfare, and there were far too many instances of unfair treatment of employees. The laborers were often underpaid; care was not even taken that they should be properly fed; they were compelled to work an excessive number of hours and in surroundings so unsanitary as not only to be injurious to their health, but sometimes greatly to shorten their lives; they were often laid off at the worst time of the year; and, having no share in the profits of the enterprise, they naturally came to look upon some of the large corporations with hostility and distrust.

As a result of all this there grew up among the laboring people a grave distrust of the great combinations of capital that came to be known as trusts, and the public

THE LABORERS WERE OFTEN UNDERPAID.

at large—the storekeepers, clerks, and laborers—all of them came to feel that corporations were huge and soulless ogres whose main object was to suck the life-blood of the people and fatten at the expense of the community. In our newspapers cartoons portray the capitalist as a huge man with a face like that of a beast, and with huge teeth, evidently preparing to tear up and eat a little insignificant person which the cartoonist labels "The Public." The picture tends to obscure a true understanding of the real nature of capital. There is nothing in such a cartoon that indicates the share labor played and plays in creating and maintaining capital, or how widely diffused is capital among the people. The poor man's deposit of fifteen dollars in the savings bank is capital. In 1919 these collective deposits in the savings banks of the United States amounted to $6,069,900,260, which represented savings of 12,000,390 depositors. This capital is likely to be invested in the very enterprises that people are growling against, attacking, and striving to injure.

The carpenter's box of tools, the sur-

geon's instruments, the storekeeper's stock of goods, and the farmer's horses, cows, and pigs, are the owners' capital. Everybody who owns a home or piece of land is a capitalist to that extent, and, while some have vastly more than others, one cannot strike at the sanctity of property rights without hurting the little fellow just as badly, and perhaps worse, than the big one, because he can less afford to lose his savings.

In this tumult of abuse the good that these combinations have done for us is too often ignored. People see the price of commodities go up a few cents a pound, and they immediately cry out that the trusts are crushing them. Their memories do not run back a hundred years or more, when things that every one of us enjoys to-day cost much more, if, indeed, they were to be had at all.

I think most fair-minded people realize now that, unless regulated, these trusts are a real menace to our institutions. People are also coming to realize the great service the trusts, properly controlled, render to the community. We should bend our efforts to minimize the evil possibilities and help along

the good. In response to the public clamor the Governments have tried to do this by various ways of regulating them, of which some are wise and some have not worked out well in practice. It will probably be many years before these problems are solved in an entirely satisfactory manner, but all efforts to choke the trusts off have been fruitless, and it is lucky that this is so, as the good they do greatly exceeds the harm.

It is most unfortunate that when capital found itself growing strong, the company managers did not see that it was unfair for capital to get all the profits, even though it did reduce the price to the public of the things it had to sell. When capital made things its laborers used, the laborers also benefited from the reduced price, but the managers should have said to themselves: "The first use we shall make of this money is to see that labor gets what President Roosevelt called 'a square deal.'"

Even if humanity had not required it, intelligent self-interest should have taught the representatives of capital that healthy laborers did better work than unhealthy

ones, and that satisfied and contented people were better friends to an enterprise than men who felt they had not received fair treatment.

It is no wonder that laborers working for insufficient wages under bad conditions should have become resentful toward the owners and managers of the enterprises whom they saw indulging themselves with the profits in which the workmen who made them possible did not share. The natural result of all this could easily have been foreseen. The laborers combined to protect themselves and formed trades-unions. I have always felt that the people who caused the trades-unions to be formed were not so much the laborers as the owners and the managers of the big corporations who failed to realize the necessity and wisdom of a partnership between capital and labor.

Many people suggest that all profit above a small return to capital should be taken and divided among the laborers. This would help the situation very little — in fact, it would probably do it a very great harm. The labor element varies greatly with

different kinds of business. In some businesses, such as water-power plants, labor plays perhaps one tenth the part of capital, whereas in others, such as certain manufacturing industries, the proportions are reversed; in the former case the laborers would be greatly overpaid, in the latter they would get very little more than they now get: in both, those who conceived and put up money for the enterprise would be discouraged and ultimately driven off, to the great disadvantage of labor itself. I mean by this that it is as much to the interest of labor that capital should be satisfied and happy as it is to the interest of capital that labor should be. Both partners must get the square deal. Neither should have a just feeling that it is treated with injustice.

Little by little we are reaching a more intelligent understanding of the relations between capital and labor and a more successful manner of meeting these problems, and I have little doubt that ultimately a wise, fair, and satisfactory solution will be found.

Unfortunately labor has not used its

new-found power any more wisely than capital did in its turn, and the labor leaders have also failed to realize the essential need of the partnership between capital and labor. It is very much as though we had a pair of horses hitched to a wagon. In order that the wagon should move properly, the two horses must pull together. If both horses put their shoulders into the collar at the same moment, and with the same pressure, the wagon will start with the least strain on each one of them. In other words, if both pull together at the same time, and neither one tries to kick or bite, or pull sidewise, or sag back in the collar, the work of both will be much less, the wagon will move more easily, and the object they are both striving for will be attained. The partnership of capital and labor in conducting an enterprise is just like this. Every time one hears of a strike or of a controversy between these two partners in business, one has a feeling of sadness and realizes that there is a lack of coöperation between two groups of friends that simply cannot get along without each other.

Now what has labor done? Having formed its unions, representing at first only the employees of given companies, the men elected officers, and then went to their employers and said they would not work unless conditions were made more favorable. So far it seems to me they did just the right thing. I do not see how they could have done otherwise. They insisted upon and received better wages, better living conditions, shorter hours, and other privileges, and worked for the abolition of child labor. I cannot help wishing that capital had had the foresight and vision to beat the laborers to it; I mean by that to have provided these things for the laborers, even before they were asked. So just as the combination of capital served a great purpose, and has been beneficial, so the combination of labor in its turn served its great and useful purpose.

But now we come to the other side of the picture. Soon the different unions joined themselves together into great numbers of laborers. Surprised and delighted with their new-found power, the labor leaders did not confine themselves to wise and far-sighted

action, but became in certain respects just as unwise and unfair in their demands as capital had been.

Labor should have been most scrupulous in preserving its own efficiency. The first and greatest care of its leaders should have been to be absolutely certain that labor be kept keyed up to its maximum power. Instead of teaching that the interests of capital and labor are really identical, and that anything that hurts one hurts the other, they have spread broadcast the same feeling of distrust and dislike of capital that we have seen growing throughout the whole community; they have made the laborer feel that capital is his natural enemy; instead of tending toward the settlement of disputes by fair consideration, they have asked for things that were beyond the power of capital to grant and still live; they have not only ordered strikes — that is, stopped work themselves — but have, by force and intimidation, prevented others from working; and they have gone so far in anger as to smash up machinery, burn buildings, and bomb and destroy the structures of the very

concerns from which they derived their bread and upon whose existence and prosperity their livelihoods depend. Our industries are competing against those of other countries and can succeed only if their costs are held down. Each strike increases these costs.

Let us look at some of the unwise methods the labor leaders have adopted. They have forbidden those they represent to work more than a certain number of hours, which is quite a different matter from securing shorter hours for factory operation; they have even tried to limit the output of each man so that the best man should do no more than the less skillful or less diligent.

Some ten or twelve years ago it was customary in and around Boston for brickmasons to lay, in a day of eight hours, from fifteen hundred to two thousand bricks in what is known as straight, plain building-wall construction; that is, walls built of common brick twelve inches or more in thickness, without special ornamental work and with only plain openings for windows and doors. Exceptionally skillful masons

would sometimes lay twenty-five hundred or even three thousand bricks in a day. But during the past few years, when brickmasons were in considerable demand and conditions were controlled absolutely by the unions, this output dropped to from five hundred to seven hundred bricks in a day of eight hours for the same class of work, or less than half of what it had been before. In spite of denials by representatives of the labor unions, individual masons have said that they were prevented from doing more than this amount of work by threats of their fellow workers to report to their unions those who exceeded what the unions recognized at that time as a maximum permissible output. But since the breaking of the Building Trades strike in this locality, which has resulted in open-shop conditions in the building industry this year (1921), it is reported that on at least one job, a short distance outside of Boston, the masons have again averaged fifteen hundred bricks a day on straight, plain building-wall construction.

Before the war it was customary for a good carpenter to lay two thousand shingles

in an eight-hour day on straight, plain roofs without hips or valleys. During the past few years this output dropped to from one thousand to fifteen hundred shingles in an eight-hour day. The lessening of efficiency among carpenters has not been, generally speaking, so marked as in the case of some other trades. There are a great many more carpenters available than there are men for the other callings; consequently there is a higher percentage of unemployment and a greater difficulty in maintaining a complete organization of the trade; at the present time, under open-shop conditions, it is reported that the carpenters are back at their pre-war efficiency.

Anybody who understands the spirit of these pages will realize that restricting practices such as these are absolutely the height of folly and will put American-made goods at a permanent disadvantage in the competition with more intelligent and less hampered neighbors. It is not only a blow at the permanence of our institutions, but it shows a failure on the part of the labor leaders really to understand the spirit of

service which gives joy to working. There is a satisfaction in putting forth one's best efforts and seeing the results come from under the hand. Everything that tends to limit the output by rule takes away the joy of working and strikes at the very soul of labor.

Although our country boasts that it is a land of freedom, the tendency of labor unions has been to limit the freedom, not only of the members of the unions, but also of the companies themselves. They have tried to tell them whom they shall and shall not employ; they have even gone so far as to insist that they shall buy materials and supplies only from concerns that employ union laborers, and in some instances they have been able to insist upon it. The companies, in a veritable struggle for existence, contend that they should be free to have what they call the "open shop," which means that they should be able to employ what laborers they choose, whether they are union men or not, and to buy their supplies from whatever concerns offer them the most favorable prices, whether the ar-

ticles which they purchase are made by union labor or not.

It is probable that the cause of union labor will suffer greatly because of its reaching out for too much. The minute that its rules make the cost of the articles it produces unnecessarily high, or the efficiency of the men unnecessarily low, which is almost the same thing, it has sounded its own death-knell, simply because people in other countries will step in and get the business.

Another thing unions have insisted upon is what is known as "collective bargaining," which means that the companies shall be required to deal with labor only through the heads of the labor unions and shall not treat directly with their own employees. The companies contend that they do not recognize the right of any outside party to step in between them and their laborers, and many bitter controversies have been waged upon this score. It seems as if some working arrangement within the companies' plants could be provided by which the managers and laborers could get at satisfactory working agreements without the intervention of

outside agencies that are not familiar with the internal affairs of the companies.

But the most serious example of folly on the part of the labor leaders came in time of war, a time when labor and its leaders had an opportunity to rise to a splendid height of patriotism and sacrifice that the wonderful service rendered by those of all ranks in the army gave us a right to expect of those who stayed at home. It was a time when no man in the country should have thought of striking; when every one should have speeded up work, realizing that only thus could a man do his bit, just as his sons and brothers were doing theirs on the other side. But although many millions of our laborers stayed patriotically by their jobs and did their part nobly and well, there were altogether too many who did otherwise, particularly among the ranks of organized, or union, laborers. Instead of rising to this opportunity, too many men gave a lamentable exhibition of selfishness and lack of patriotism. The records of the Labor Bureau in Washington show that the number of laborers who could have worked and

did not because of strikes or unwillingness, multiplied by the number of days when they were idle, gives a ghastly total of sixty million days that were lost in our years of greatest need. Over ninety per cent of these men were affiliated with labor unions. And not only was there a great and inexcusable amount of idleness, but there was a sharp falling off in efficiency also.

Under Government control and at a time when hands were scarce, the number of employees on the railroads was greatly increased, without any increase in efficiency of the service rendered. This sorry picture goes into altogether too many pursuits to make us feel entirely happy.

I have profound confidence in the patriotism and right-mindedness of the average American laborer and I feel sure that he lacked only the inspiration of high leadership to have risen to these opportunities, and it is hoped that leaders who have the vision and the power to inspire their fellow workers will rise among the laborers so that this sort of thing will never happen again.

We are still far from reaching a wholly

satisfactory solution of these problems. It is clear that at first capital got too much power and abused it, and that later labor did the same thing. Both were at fault and each must shoulder its share of the blame. The partisans of each are inclined to blame the other. To my mind, capital, having erred first, cannot escape a just criticism for the conditions that naturally followed.

It is, however, very hard to get any fair basis of division of profits and of responsibilities. Conditions differ fundamentally in different kinds of business. For instance, while laborers want to share profits, you never hear them suggest also sharing losses. Of course they could not do that. But if capital is to give up its profits and still take losses, what inducement is there to keep on in business?

Apart from the organization of the laboring people, other groups of people, inspired by the common feeling of dislike and distrust of corporations, have associated themselves as organized societies and parties, and in some cases even governments. Some of these people go by the name of Socialists, some

are called Bolshevists, some are merely cranks, often very worthy and quite lovable souls whose only difficulty is that their hearts are more powerful than their heads, as they have been provided by a Divine Providence with a great power of feeling, but denied the power of thinking accurately and clearly.

Let us stop for a moment and consider this matter of Bolshevism, a new, and of Socialism, an old word in our vocabularies. The Bolsheviki (it is a Russian word) are nothing more or less than people who want more; and, if they were fair, just, and honest, and understood the political, social, and economic structure necessary to do what they want, there would be no danger and no evil in the term.

The trouble with the Bolsheviki is that they are an ignorant set of people who were themselves unfairly treated in the past by the people of wealth in Russia. It is hardly surprising that these ignorant Bolsheviki do not realize that the way to get more is not to rush in and grab things. They cannot foresee the disaster that follows as soon as they

destroy property rights, management, and all the niceties of the machine by which they and all orderly communities live and prosper. It has not been made clear to them that their best interest lies in increasing the output of all the things they want, imbuing the community and each member with the spirit of world service and letting them understand that three things are necessary for the acquisition and ownership of wealth. The first of these is public order, which means the protection of every one, rich and poor, in the pursuit of his lawful aims and in the ownership of his property. The second is the maintenance of the great arteries of trade, commerce, and business, such as the railroad and steamship services, and the banking and trading corporations. The third is the encouragement of each last, least person to put forth his best efforts in the work he is best fitted to do, in the assurance that some way will be found by which he can exchange his output for the output of others.

Bolshevism, or wanting more of the good things of life, is good just as long as it carries with it the willingness to serve and sacrifice

in order to earn them. The trouble with Bolshevism, as seen in Russia, is that the Bolshevists want to receive more and want to give out less. Smarting under a sense of injustice, they saw red, and set out to destroy wealth instead of to regulate it. Not realizing that wealth is necessary for the stability of society, they foolishly cut away the props and the whole house fell. To-day throughout Russia anarchy prevails, disease stalks unchecked through the country, money goes out and starvation comes in, there is no safety of life, innocent people live in terror, the streets run rivulets of blood, and all the horrors of barbarism are abroad in the land.

Socialism differs somewhat. The Socialists have the same objection to wealth, and they fancy that if all wealth were divided up, the poor made less poor, and the rich all made poor, the world would roll along in a sweet, soul-satisfying atmosphere of social justice and all would be well. These theories are usually most popular with those who have less of the world's goods than many of their neighbors, and who therefore

think that if such a plan were to be adopted they would get more without doing any more work for it. They are also quite popular among some who have found themselves well supplied with worldly goods, usually through the efforts of others, and who are really beneficiaries of the system they delight to criticize. Just what they would do and how they would get along, were the means of livelihood taken away, it is rather hard to say, as these people are apt to be stronger in feeling than thinking, and on the general theory of chance could not earn very much.

One of the remedies that most of these reformers unite upon is ownership by the Government of the businesses; they think that if a Government, elected by the people, should take charge of business, the public interest would be protected. Unfortunately for their argument, Government management of business has never succeeded. Occasional instances have been found where Government business has been well done; but it is almost never efficiently done, the costs are usually excessive, the service is

generally poor, and, like most of the remedies suggested by our Socialist friends, it does not work in practice.

During the war the United States assumed control of the railroads, and the telegraph and cable lines, fixed prices of a number of commodities, and in general carried out a good many of the measures favored by the Socialists. One fortunate result of this is that the American people have had an object lesson and realize how unsuited Government management of corporate enterprises is to a democracy. Managers are too apt to be appointed because of the service they have rendered to the party instead of because they are fitted for the job. Discipline is very apt to be lax because the party leaders are afraid to lose votes if they are strict. Political leaders are notoriously careless of the manner in which they expend public moneys, and the result is that the costs soar into the blue sky. Officials of the Government are always reaching out for more power and have to be restrained from mixing into business by the existence of a strong public sentiment against it. That the

Government should as far as possible stay out of business has been one of the cardinal precepts of Anglo-Saxon civilization. The Government's relation to business is to interfere only to stop abuses, check and discourage excesses, make the necessary laws to protect the public, and punish those who do not observe these laws. If the Government runs the business there is no one to regulate its conduct.

There are three classes into which business may be divided: A first group, which is considered to be properly the business of the Government, includes the construction and maintenance of streets, public buildings, sewers, and waterworks — although sometimes the supplying of water is let out to private concerns for profit. A second group includes those businesses which are commonly known as quasi-public corporations, — that is, they get some privilege from the Government, such as the use of streets, and do business for and with private individuals, — among which are the railroad, street railway, telephone, telegraph, gas, and electric light companies. And the third group

is made up of purely private corporations engaged mostly in manufacture and trade.

Some cities in the United States are making experiments in the ownership of municipal facilities, such as lighting and street railways, but I do not think a single case can be found where the service is satisfactory and the costs are low; if there is such a case, it bespeaks an unusual condition and one likely to terminate when the particular administration that happened upon that kind of competence in its public officials goes out of office. Government ownership in itself is not so dangerous and harmful as is Government management. Where enterprises can be launched or conserved only by the use of Government capital, wise Governments will reach out and secure private management on the best terms they can.

Bolshevism has already, in its brief moment of existence, been proved unwise and unworkable; Socialism, also, is not a very great menace because it carries within itself its own cure, like some forms of bacteria which infect us — the residue left by the

microbes is poisonous to similar microbes; in the course of time they not only die, but also leave the body in which they have been operating immune from similar attacks for a considerable period.

So it is with Socialism. Every experiment in Socialism so far made has been a failure, and a healthy community, when purged of socialistic fallacies, is immune to them for a good long time.

In my opinion, the real solution to the problem existing between capital and labor lies in bringing home to both parties a realizing sense of the fact that they are essentially partners, one and inseparable, that neither can do without the other, and that each must find some way of giving the other a square deal. Capital must be assured of its property rights and its profits if the business is to be properly operated, and labor must be sure of its wages, good working conditions, and healthful surroundings. I have always thought that some way would be found for insuring each laborer, so that after a long period of faithful service he need have no fear for his family in case of death

or disability; and it seems only fair that there shall be some system of pension for those whose long years of service give them a claim. Perhaps this could be brought about by joint contribution of the laborers, the companies, and the State.

I believe that some method will be found by which a fair-minded board will compute the part that labor plays in each class of enterprise, corporate or otherwise; that some device will be found by which the active partnership of labor with capital will become recognized, so that labor will have representation in the management whenever questions that pertain to labor come up for decision; and that some general plan will be devised by which labor will receive direct benefits from the profits of the company and thus share in its prosperity and have a direct and immediate interest in its success.

Much has been done in this direction. Many companies have laid aside a portion of their shares at less than market price, to which laborers have been given an opportunity to subscribe on the installment plan, thus putting the shares within the reach of

most of them. It has become the practice for corporations to maintain a regular medical establishment, with doctors, nurses, and rooms, for the free treatment of operatives. Workingmen's councils have been formed with which the management consults as to the working conditions, when it is necessary to lay off some of the force or to reduce wages, and, by explaining the financial condition of the company, enables the workingmen to see that the cut was actually necessary and was not made from any lack of interest in their welfare.

I have sometimes thought it possible that a state fund could be established to which all corporations should contribute a portion of their earnings, this fund to be available for relief and assistance of clerks and laborers who get a right to share in it by contributing a portion of their earnings. The participation could be made greater for those who have worked continuously and faithfully, in order to discourage frequent changes of employment and intermittent efforts on the part of the laborers. It seems right also that the State should have a share in the profits,

perhaps in place of other forms of taxation.

In America we have a better standard of living for all our working classes than is to be found anywhere else in the world. Our poor people get more comforts, conveniences, and pleasures than the poor of other countries, and have come to regard as necessaries things that are unobtainable in many other countries. All Americans should be proud of this high standard of living and make it their study and ambition to see that it is maintained.

People of a philosophical turn of mind sometimes ask themselves whether all this great development, all this vast increase of power, that has come in our late civilization is, as our fathers used to say, good in the sight of the Lord, and whether mankind is any better for it. Is it not possible, they ask, that this power will be abused and lead us into ways of evil rather than into the paths of righteousness?

The answer is simple: The growth of business and the rapid creation of wealth have made possible our greatly improved living conditions, our advance in literature,

art, and science. To doubt the wisdom of adding to our power for fear of making bad use of it is like doubting the wisdom and goodness of God. We should strive to increase our power and then bend our efforts toward shaping our public law, our private code, and the instruction of our young people in the home, school, and college toward training them to use this power wisely and well.

IX

THE POWER OF THRIFT

WE now come to the end of our series. We have seen the beginnings of business as it manifested itself first in the home, where specialization begins, then in the village, and later we have seen how it has spread to the State and to the Nation, and we have followed it through until it has finally come to assume world-wide proportions. We have traced some of this development from its beginnings, as in the things we eat, the things we wear, and other things we use. We have indicated the magnitude of the service rendered by steel, the manner and extent to which electricity has entered into our lives, and how the essential art of transportation formed and grew; and we have told how far all this has been made possible by the system of banks and currency that has grown inseparably with the rest. Finally we have examined some of the more difficult problems that have arisen in connection with

this development, especially that of capital and labor.

We have seen that business properly conducted is always service and that service rendered for pay is usually business.

We have watched the result of this growth of business and have seen how it has raised peoples from absolute savagery — a few huddled half-naked creatures in crazy shelters of grass, mud, and leaves, wondering what scourge of pestilence, or savagery of man or beast, will next fall to their lot — to the comfort and security of the present times in our own country, where laboring people have an abundance of things we now regard as necessaries, which before were regarded as luxuries reserved only for kings, or were even, as in the case of modern medicine and surgery, beyond the reach of the most powerful of the emperors of old.

What could Pharaoh or Alexander the Great have done when the smallpox raged? Who knows but that the blindness of Homer or of Milton could have been cured by a very simple operation?

We have watched specialization grow and

spread until now only a few people, by the use of modern methods, appliances, power, and machinery, can do the work formerly done by very many of their fellows, as is shown most strikingly in the case of the locomotive engineer, who, with a train-crew of not more than ten men, carries loads that would formerly have needed the backs of more than a million men.

We have seen similar development of carrying-power by sea and have noted the great increase of efficiency that has come from the development of the water-power and its transmission in the form of electricity, tracing it from its first beginnings in the flour-mill of the ancients to its present marvelous development at Keokuk, where more than one hundred and fifty thousand horse-power is handled by a small staff of employees. Of that, some sixty thousand horse-power is carried nearly one hundred and fifty miles to St. Louis, where it performs all kinds of services for the fortunate people of that city, and the rest is distributed along the two main lines, one down the river to St. Louis, and the other up the river

to Davenport, Iowa, and over the more recent circuit lines, one of which carries to the cement works at Continental, Missouri, one of the largest single loads transmitted from any power plant, four thousand horsepower.

This specialization has reached a point where numberless people spend their lives making articles for which they have no personal use, as a man of perfect eyesight may spend his life grinding lenses for glasses for those whose eyesight is defective. He does this without any sense of loss or sacrifice, as he is well paid for his labor, and with the money can buy things he does want.

It has come to pass that the things we use to satisfy our daily wants are drawn from so many and such various parts of the world that the tale of it nearly staggers one's imagination. Here is a watch assembled in Switzerland, of steel that may have come from Germany, silver from Mexico, and jewels from India. And so it goes.

We brush our teeth with bristles from Siberia; wear clothes made of wool that may

have come from Australia or the Argentine and shoes made of leather from Brazil, or from one of our own Western States; one spoonful of our breakfast may easily contain products of three continents. We are walking exhibitions of the world-wide extent of our interests and we do not realize a tenth — no, not even a hundredth — part of it, so used have we become to having miracles performed for our benefit. Alas, how many of us have joined the "anvil chorus" of silly denunciation of the system of business and commerce that has brought about all these wonders.

It is possible, however, for specialization to carry us too far. There are limits which should, in all prudence, be set to it. We must be sure that we are self-contained and capable of self-support. We do not desire, for example, to be dependent for our food-supply or our articles needed for self-defense upon people too foreign or too distant for us to be sure of their continued support in time of stress.

In the home, even if others can do things cheaper and better, the youth of the country

should learn how to take care of themselves; they should master manual training and understand the use of tools; they should understand the use and care of machinery, and, if they live in the country, cultivation of the soil; they should learn to shoot and to understand something of woodcraft and of the care of animals. And just as each person, no matter what his future occupation is to be, should have his body properly and normally developed during the years of growth, so each nation should, in the interest of normal growth and as a measure of public safety, provide means by which all essential functions could go on, even were the seas to be closed and, by reason of war or boycott, its sources of supply from outside be shut off.

Let us now look forward for a moment and see where all of this is leading us. We have seen the extent to which men have already gone in utilizing the forces of nature, and it is not too much to surmise that even greater advances will yet be made and new forces discovered far more potent and extraordinary than anything yet known; but none of us can foresee the lengths to which the people

of the future may carry these same measures. Our present supply of power per man may be increased ten times or more, and give us a corresponding increase in the wealth or stored-up labor of the human race and a corresponding betterment in the living conditions of everybody, until the people of to-morrow will be as much better off than we are to-day as we are better off than the savage of yesterday.

How, then, is this to be brought about, and what part in it are we all to play?

To answer this question, we must look into the nature of capital, or wealth, and see in what it consists and how it is created. We have many times spoken of capital as stored-up labor, and I know of no better definition that can be given to it. Take, for example, a pocket-knife, often a small boy's most treasured possession — his idea of wealth. Its price, let us say, was a dollar and a half, and the hardware man who sold it paid eighty cents for it, and took seventy cents for his expenses and profit. Twenty cents of this probably served for wages and perhaps twenty cents more for rent and upkeep,

leaving thirty cents for his profit, which represents the payment he gets for his labor. The eighty cents paid to the manufacturer went in part to his laborers and in part to pay the light and power bill, and part was paid for the raw material, that is, the steel of which the knife is made. When you come to analyze the making of light and power, you find that the laborers make up the larger part of the cost of producing and selling electricity; and an examination of the books of the coal mine will reveal some interesting facts in regard to coal. If you pursue your investigations still further to the smelter and the iron mines, you will again find that labor is the principal element in making up almost any figure of costs. All our lines of investigation of cost will presently bring us to the interesting discovery that labor is the largest element, which strengthens our confidence in our definition of capital.

Land also is capital, and the ownership of land is regarded as evidence of wealth; but here again, strange as it may seem, we find that the controlling element in creating value is man's work. I have seen vast tracts

of land in Brazil covered with virgin forest and blessed with soil and climate unexcelled anywhere; and yet this land could be purchased for thirty cents an acre. Why? Because it had not yet been made available for human use. It needed railroads, with all the necessary equipment of engines, cars, stations, sidings, and round-houses. It needed highways, fences, buildings, clearing, ploughing, and the necessary number of men and animals, all of which means work by men. When all these things are provided, instead of being worth thirty cents an acre, we are likely to find it worth somewhere between one and two hundred times as much. So it is fair to say that much of the value of improved land is the direct result of labor.

We have seen the beginning of wealth. It was first in the form of the crude garments, the implements of husbandry, hunting, and warfare, such as stone axes and arrow-heads, and the rude huts that served as shelters. Later we have seen it developed by the planting of more than enough for one year's supply of corn, thus creating a store of wealth. Later still, we have seen the village

profiting by a good water system, and so have got a still larger idea of the service rendered by property.

Let us see the various forms that property takes and then think how we should get along without any of them.

As a nation, our property, besides public buildings and the public lands, is in national libraries, museums, fortifications, arsenals, ships of war, and river and harbor improvements, including works for irrigation. The State also owns buildings, universities, prisons, harbor works, and sometimes hospitals and asylums, while there is also growing up throughout the United States a vast network of roads owned and maintained by the State. The towns have town halls, libraries, hospitals and museums, streets, sewers, waterworks, public wharves, warehouses, schoolhouses, parks, and playgrounds; and recently some of them have been going into the ownership of public utilities, such as street railways and electric light or gas properties, without, I fear, greatly improving the service to the public.

Private property is seen in many forms.

It is largely found in the ownership of various articles of personal use — all workingmen's tools and implements are property or capital, as also are household goods, utensils and furniture, and land and houses, whether in the city or on the farm. It often takes the form of deposits in the postal or other savings banks, in Government bonds, or in the ownership, either direct or through the shares or other securities, of businesses. These businesses may be designed to serve a great variety of human needs. We have traced the story of some of them: there are factories, farms, plantations, apartment-houses, mines, power-houses, printing-presses, studios, privately owned schools, universities, hotels, hospitals, storehouses, wharves, ships, automobiles, and animals. The list is far too long to give even a slight indication of its scope and variety.

All these have been made possible by our work and that of our fellow-men. And had we been more prudent, more energetic and efficient, and, above all, less wasteful, the list would be many times greater than it is now.

It has been said that the total value of all the wealth of the world is not greater than the value of one year's labor. If that be true, it is a sorry commentary on the capacity of the human race to create wealth of a durable sort. What is the secret? How shall a man go about it to serve humanity by helping to produce wealth? The answer is very simple: by producing more than he consumes. This can be done by learning some trade or art or science by which he can earn something, and then, by means of thrift and careful management and the avoidance of all waste, by so conducting his life that he save something each year and thus add to his possessions or to those of others whom he serves, or to those of the State.

And what is your job, and mine? What particular part can we play personally in this work? First, we can train ourselves to work at the thing that we are best fitted to do and that the world wants. There is no hardship in this, because it will prove to be the straightest road to happiness. Second, we can so school ourselves as to be worthy of the great responsibility that comes with

ownership of wealth. We can make sure that with the power to gratify our desires and whims there comes the power to resist the temptation to gratify unworthy desires. Third, we can learn to avoid all waste and unnecessary destruction of things that it costs labor to make. We should learn to respect the toil of him who has served; to share with him the joy of making and to see to it that none of the handiwork of our fellow-men shall have been brought to naught by thoughtlessness, carelessness, or ignorance on our part.

It is a curious fact, true of many people, that the richer they get the poorer they feel. This curious phenomenon is easily explained: a man of very moderate means must make his choice of purchases among a very few objects. He has to provide food, clothes, and shelter for himself and family, and choose among the less expensive forms of all of these, and this greatly limits his power of choice. It enables him, however, to select a fair standard of living in which he can be very happy. Multiply his income by ten and you have multiplied his power of choice by

a thousand; and, looking about to select the new things to purchase, he is likely to set his heart on many things that he presently feels are beyond his increased purchasing power. Men of ready imagination whose power of self-control is limited feel themselves thus led on into wanting a great many things that they would be just as well off without; and many such men get harassed or discontented, or even go into debt to gratify their fancies.

To some people the inheritance of wealth is no advantage. They succumb to the temptations and fail to rise to the opportunities.

It is an unfortunate fact that many of our men of great wealth attract public attention only when the newspapers find out and publish accounts of their family difficulties. The reason for all this is, probably, that they had failed to learn the great lesson of self-denial and of unselfishness in their home lives, and, hence, became inconsiderate and difficult to get along with to a degree that finally wrecked their homes. The remedy for this evil is not to break up the

principle of wealth, which in the last analysis would discourage progress and largely devitalize business, but to take greater care in training men to handle property when it finally comes to their hands.

I believe the school of the future will be much more devoted to the development of character than of scholarship; not that scholarship will be neglected, but that character will be emphasized. All tendencies toward greed, self-indulgence, inquisitiveness, jealousy, vanity, and so forth, will be studied and exercises given gradually to train the youth to grapple with, and overcome, undesirable tendencies, until he is sent out into the world far better equipped to fight successfully the great battle of life than he would be if sent forth when already under the dominion of some undesirable trait.

Consider in their turn the three ways of helping to create wealth: the first, we have seen, is performing some service. It does not matter whether you are paid or not, if the service is real. It is usually better for all if services are paid for; it means that the service is rendered more regularly and more

efficiently than if done by volunteers; and in a larger sense justice is best meted out in this way. The world pays for what it gets, and it is possible that some of our wealthy men, who have played the game of business creditably and squarely and according to the rules, have rendered service greater than everything they have received even if they have accumulated fortunes of several million dollars.

This is, perhaps, as good a place as any to remark that the very worst policy for the owners of any business is to be niggardly about the salaries paid to men at the top. Some men are so necessary in business that no price will be too high to secure their services. It is not unusual for large corporations to pay salaries to their presidents running as high as seventy-five and a hundred thousand dollars a year; and in such cases they are usually worth that, and more.

I lay emphasis on this because many people, particularly those working for moderate wages, are inclined to look on large salaries with disfavor. My attention has recently been called to a bank that sent a

low-salaried clerk to start a branch. By neglecting some of the simplest principles of business prudence he made transactions in a few months that netted his bank a loss estimated to exceed five million dollars.

Even if you do not earn money, and depend on income from securities or an allowance, the same principles in regard to saving and avoidance of waste apply.

It is a good rule to live as simply as possible and, by deposits in the savings bank or by making careful investments, to turn back your excess income to the community for the development of further industry. I know certain people — good, intelligent people, too, who should have been properly trained — who feel it perfectly proper to spend the whole of their income, no matter how large it grows, and who seem to have no realizing sense of the desirability of saving some of it to turn it back to industry by investing it.

The cultivation of simple and frugal habits, besides being good for the health, has the incidental advantage of serving to train the character and fit one for taking on the responsibilities that come with money.

And now we come to one error of which we Americans are, all of us, guilty, individually and as a people. I speak of waste. We are terribly, continuously wasteful — wasteful of our food, our clothes, our money, our articles of use for work and play, our time, and our opportunities.

In Emerson's poem "Days," he tells of the wonderful gifts the endless procession of days come bearing, ready to offer, and after he has made his choice he says,

> I, too late,
> Under her solemn fillet saw the scorn.

The Chinaman is probably the most frugal and the least wasteful man on earth. He has to be. There are believed to be some four hundred million Chinamen in his corner of the earth, and they lack capital, machinery, and the means of communication and of international interchange of produce; so that their communities are too much self-contained and cannot earn largely. They must save or starve, and even with all their prudence and thrift they sometimes starve. At the hour of writing this paper, a fearful

famine is going on in China and many people are dying of starvation. One never sees a Chinaman lose anything. China that he handles is never chipped or broken. When he supplies food, he has exactly enough, not too much or too little. With him thrift is an exact science.

Lack of commercial opportunity brings it to pass that the Chinaman does not create wealth very rapidly. He produces little beyond his needs, small as they are. The Frenchman is the greatest wealth-producer there is, because he has his great power of production combined with a deep-rooted sense of thrift. He will always lay by something; and hence he is a builder. It is fortunate that this is so, for had it been otherwise the French people could never have withstood the strain the burden of war placed upon their finances.

Our people, with their energy, their power, their ingenuity and spirit, have progressed more rapidly than any other. We are the largest producers of any. But here the greedy ogre Waste comes in and uses up very much the greater part of what we

produce. Even the children begin the mad dance of destruction; idolizing parents and relatives lavish toys upon them and laugh to see them tear their books and smash their dolls. Instead of being taught conservation from the very beginning, they are allowed to break, tear, and indulge in riotous disorderliness so that they enter upon life handicapped. If they were to learn with each new toy its proper place, were never allowed to use it without putting it away, even in early infancy, and if they had among their earliest impressions the sanctity of property and its orderly use, they would start life much better equipped for its battles.

The desire for destruction is with us all. Who does not want to throw a stone through the window of a deserted house or take a shot at a signboard or do some other little or big act of vandalism?

Look at the destruction that the untaught soldiery bring upon the property of those whose places they occupy. Broken furniture, slashed pictures, and ruined decorations mark the path of invading or retiring armies. It means that something is lacking in our

civilization; and the something is education. This trait of man can be cured only by an appeal to his intelligence, his inherent sense of fairness, and his better nature.

One of the most glaring forms of waste of which we are guilty is that incidental to the condition of our roads. We have the money, the brains, and the organization in our country necessary to have built and properly maintained an adequate system of highways, which should by this time have reached every town and village of the land, and which should have passed every schoolhouse and every church; and yet how backward we are!

The Romans marked their progress and their civilization by the construction of roads; and so well were their roads built that even now, after the lapse of more than a thousand years, the old Roman roads are the best. Where has that art gone? For our country roads we cart a little gravel, dump it on the rough places, and think we have repaired them. The water lies in a thousand little puddles, ruts form, the cars and teams bump and skid, scattering the pebbles, and

pretty soon the poor semblance of a road has become once more scarcely passable.

Even the more carefully built and oiled or asphalted macadamized roads have only a few months of excellence. Every irregularity of surface that causes a jolt or jounce, every rut and every puddle in our roads, is evidence of the backwardness of our civilization. It proves that we have not yet learned the intelligent and economical method of providing for our needs, and it is also probably proof of inefficiency, and even graft, on the part of our officials, present or past.

I will leave to mathematicians the task of calculating the dollar value of the loss to the community from bad roads, but I can confidently assert that, counting the cost of repairs of roads and vehicles, and the loss due to increase in time, fuel, and tires, and to decrease in carrying capacity of cars and carts, the cost will run into many hundreds of millions of dollars each year — enough to affect materially the burden of taxation upon each of us.

I used to tell the people of the Philippine Islands that they were too poor to do things

badly, and that they had such small revenues that we had to make sure that each dollar did the best work it could for them. So we not only insisted on good construction, but we maintained a force of men constantly at work to see that each section of highway was kept at the highest pitch of perfection; and we found in practice that, besides giving us better roads, this method cost less than the crazy, wasteful process of letting a road go to pieces and then trying to patch it up, as we commonly do in America.

Now, what part can we take in this matter of saving waste? Well, we can all do our bit: we might make a rule to try to leave everything in a little better shape than we find it. If there is a rock or brick in the road, move it to some suitable place. Care for all of your own property, including your less important possessions. Oil the barrels and works of your gun before you put it away, dry your fish-line, fold your clothes, clean out and place in order all the rubbish corners of your house. Most of us create a little disorderliness in the rooms we occupy. Why not create a little bit of orderliness here and

there? Put the books back on the shelves, straighten out the papers on the desk, replace the cover on the inkstand. It does not take much, if any, time.

I go so far as to believe that if some country should make thrift compulsory, teaching all the elements of it in the schools and insisting on it as a qualification for citizenship, that country would forge ahead of all others in its rate of progress. They might give the suffrage only to those who had consistently laid aside a moderate proportion of their earnings, and make a larger proportionate saving a prerequisite for holding office. Thus they would put a premium on prudence and foresight which are most valuable qualities in public officials.

These measures, however, are not likely to commend themselves to a democracy, so we can dismiss them as impracticable; but it is practicable to teach the wisdom and necessity of thrift and to try to get a healthy public sentiment in favor of it. It might be possible for the Government and for corporations to announce that they will give preference in employment and promotion

to those who have savings, or to give them privileges in regard to benefit funds and pensions, or even to give a higher rate of wages to such persons, — they are worth more to their employers, — so that it would be brought more forcibly home to every one that a man cannot afford to "blow in" all his wages. If an employer of labor makes it a rule to ask applicants for positions what they have saved and invested, and allows himself to be largely governed by their answers in making his selections, he will make few mistakes.

The trail of progress has been blazed by leaders whose names stand out above others for their ability and character. These men are the captains of industry, and many of them started as ordinary laborers. Where would they have been if they had not early shown enough foresight to begin saving? They would have stayed just where they started.

Do not think that I am trying to take all the joy out of life or that I recommend a colorless career of self-chastisement and niggardliness. I want to see all the joy that

life can have poured into it in abundant measure. I believe in sports, entertainments, social pleasures, and all kinds of healthy relaxation and recreation. I have always been a devotee of sport. A man should be able to enjoy all the pleasures life can hold and still make a creditable record of saving. If you make up your mind to lay by a certain percentage of your earnings against a rainy day, you can still have plenty of fun out of life. Cut out the poorer class of expenditures, the unprofitable and unwholesome things, and concentrate on the best.

Go at your work with spirit and enthusiasm, and you can rest assured that the world holds for you no greater satisfaction and happiness than in doing the thing that you are best fitted to do, doing it well, and feeling that you have earned the respect and confidence of your fellow-men.

THE END

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